AY 1947
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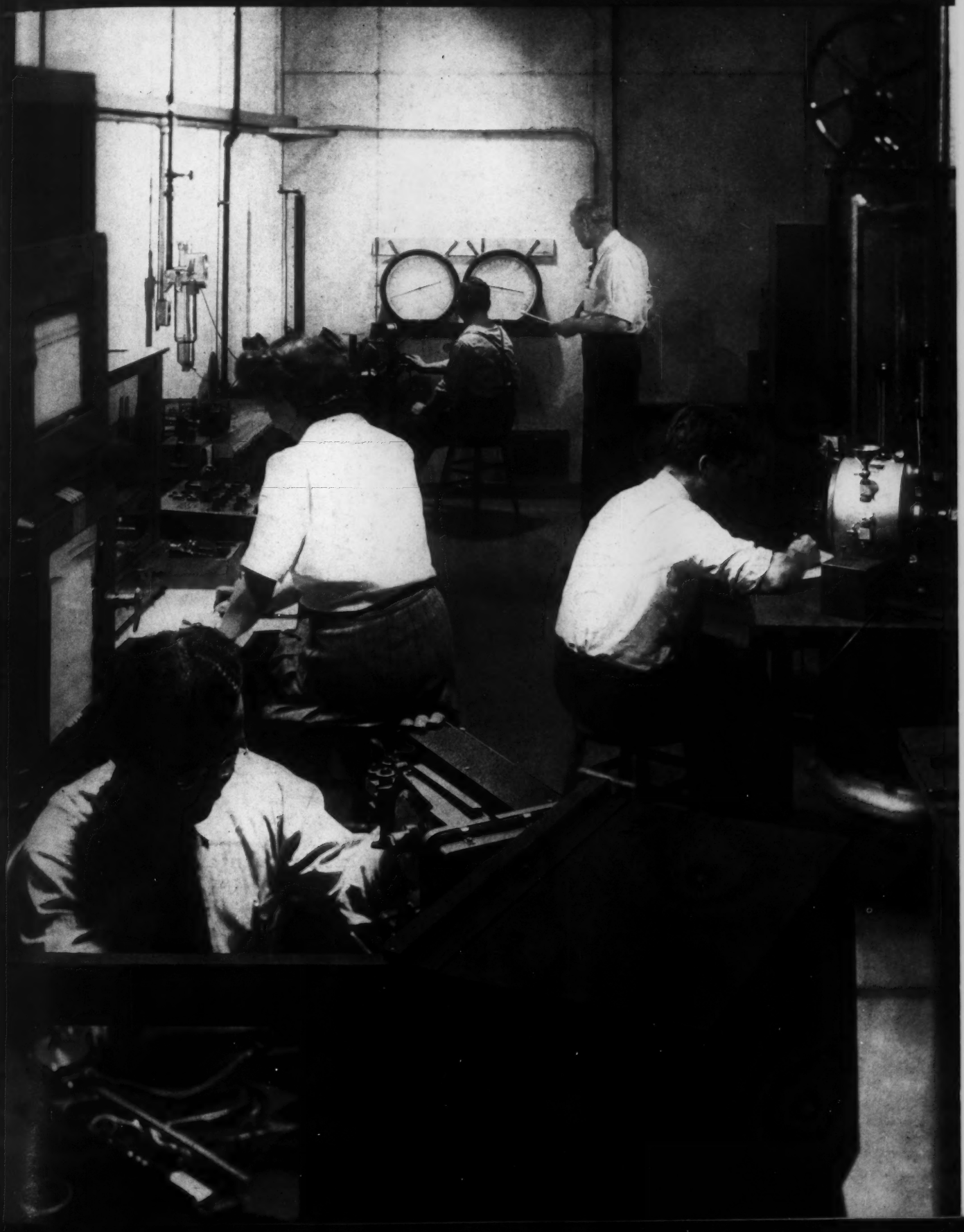
Instruments

HE MAGAZINE of MEASUREMENT and CONTROL



WHEN *SPEED* IS THE *NEED*

Only TAG *gives you...*

- **2 SPEED RECORDING**—Fast (3 to 6 seconds) or slow (30 to 60 seconds).
- **NO FALSE RECORDS**—Prints only when in balance.
- **VARIABLE CHART FEED**—Adjustable to 5 speeds.
- **CONTINUOUS ACTION**—Minimum of moving parts.

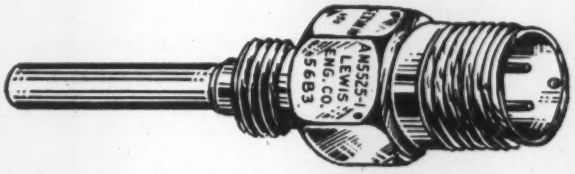
Write for the TAG CELECTRAY *Pyrometer Catalog No. 1101-H*

There is a complete line of TAG Celectray Pyrometers, all featuring high-speed photo-electric action and extreme accuracy. *Large illustration shows 29 of 350 Celectray Recorders in the control room of a prominent oil refinery.*

always specify **TAG**

C. J. TAG*liabue Division*

—THE LEWIS RESISTANCE BULB—



MODEL 56B3
(AN5525-1)

THE LEWIS RESISTANCE BULB MEETS EXACTING SPECIFICATIONS

✓ **RESPONSE TIME** — Averages 5 seconds from 100°C to 10°C when taken from boiling water to an ice bath.

✓ **HERMETICALLY SEALED** — Silver Soldered Assembly, by means of modern induction heating methods. The Terminal Pins are sealed in glass to the metal cap as in electronic tubes.

✓ **HIGH TEMPERATURE OPERATION** — Built to withstand a test temperature of 300°C for one minute. Bulbs model 56B5C and 56B6 will withstand operating temperatures of 500°F for a minimum of 500 hours. Model 56B6D will withstand 300°C for a minimum of 8 hours.

✓ **TOUGH** — Built to "take it" of Stainless Steel. The stem is of 18-8 type 304 (AMS5560A) and the head is constructed of Type 303 (AMS5640B). Polarizing Pin is of unique construction to prevent bending, twisting, or becoming loose.

✓ **STANDARDIZED RESISTANCE Vs. TEMPERATURE** — The resistance - Temperature characteristics meet "AN" specifications from —70°C to +200°C, and have been extended to 300°C.

✓ **ACCEPTED AS STANDARD BY LEADING AIRFRAME MANUFACTURERS** —

These Bulbs are used as standard equipment on the following Aircraft:—

BOEING STRATOCRUISER 377

CONSOLIDATED 240

DOUGLAS DC-6

LOCKHEED CONSTELLATION 49

MARTIN 202 and 303

REPUBLIC RAINBOW RC-2

THE LEWIS ENGINEERING CO.

Specialists in Engine Temperature Measurements

• NAUGATUCK, CONNECTICUT. •

• POTENTIOMETERS • • • • • • SELECTOR SWITCHES • • • • • • • • • THERMOCOUPLES •
• PYROMETERS • • • • • • RESISTANCE THERMOMETERS • • • PROTECTION TUBES •

The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions.

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 487.

Inclinometer Tube for Prime-relay Functions

New "Y-Type Position Convectron" is a Y-shaped gas-filled non-emission tube capable of giving an appreciable signal relative to its position about vertical. Fig. 1 shows it one-half size. Signal polarity (or phase if a-c. operation) obeys whether displacement is to left or right of null, so that tube can be used in control systems, servomechanisms, self-balancing instruments, etc. Signal strength depends upon rate at which gas convection currents leave heated filament and rise vertically, and upon angle that filament makes with vertical. Tube's "time-constant" is approx. 0.1 sec. Signal is approx. 50 mv. per degree at null. A-c. noise level 1 to 5 mv. (d-c., zero). Since tube has no moving parts and signal is obtained directly without oscillation, tube offers solution of problems inherent in older methods of obtaining vertical reference. With d-c. operation, ultimate sensitivity is one second of arc if certain precautions are taken. — *Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.*

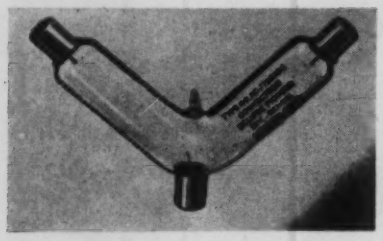


Fig. 1

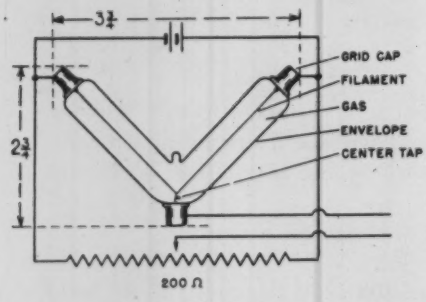
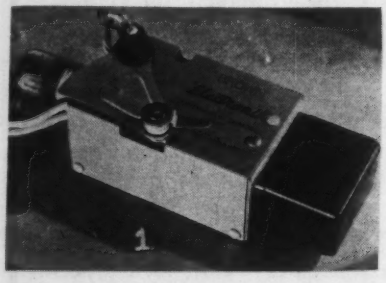


Fig. 2

Please mention number 501 when filling out card

Adjustable-mode Control Unit

New "Electr-O-Vane" unit is for use with temperature and pressure instruments. Announcement states: "Electronic principles of continuous control have been developed for the first time in the industrial thermometer and pressure gage field . . . some processes heretofore controllable only with electronic potentiometers can now employ the new instrument to obtain wanted results." Principle: "when a metal vane is interposed between two oscillator coils, state of oscillation can be made to change or stop in an electronic circuit . . . to operate a load relay." Oscillator coils are molded in Bakelite and are moisture-proof. Unit is self-contained, easily removed, unaffected by dust or dirt.—*Brown Instrument Co., 4482 Wayne Ave., Philadelphia 44, Penna.*



TYPE OF CONTROL ACTION	NUMBER OF CONTROL UNITS	CONTACT ACTION	CONTACT LOAD RATING IN VOLTS
"ON-OFF" CONTROL ON SINGLE-PEN INSTRUMENT	ONE	A B 0°F. 300°F. 600°F.	10 AMPS.
TWO POSITION CONTROL ON SINGLE-PEN INSTRUMENT*	ONE	A B 0°F. 300°F. 600°F.	6 AMPS.
THREE-POSITION CONTROL ON SINGLE-PEN INSTRUMENT* (ONE INDEX)	TWO	A C B 0°F. 600°F.	6 AMPS.
THREE POSITION CONTROL ON SINGLE-PEN INSTRUMENT (TWO INDICES)	TWO	A C B 0°F. 600°F.	6 AMPS.
TWO POSITION DUAL CONTROL ON TWO-PEN INSTRUMENT (TWO INDICES)	TWO	A B 0°F. 300°F. 600°F. A' B'	6 AMPS.

Fig. 2. *ALSO AVAILABLE ON TWO-PEN INSTRUMENT WITH CONTROL ON ONE PEN

Please mention number 502 when filling out card

Gas Regulator and Valve

New "No. V482" and "V882" control for domestic gas burners combines a magnetic gas valve with a weight and spring-loaded combination regulator. Diaphragm is of type N synthetic buna with a nylon insert. Device will be available in ½" and ¾" sizes, will carry a pressure rating of 8 oz./in.², will be adaptable for use with butane, propane, sulphur gases, as well as natural gas. — *Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.*

Please mention number 504 when filling out card

Lens-testing Projector

New testing projector is especially designed for final inspection of completed and mounted photographic lenses. A target, imprinted with a series of minute replicas of a specially-designed testing chart, provides image which is projected through lens being tested and onto screen. Each chart is so placed on target that entire image field may be examined for all types of abberrations. By remote control, one operator standing near screen moves lens back and forth within instrument until image is in exact focus; and determines whether lens meets required standards. A second operator interchanges lenses to be tested and checks uniformity of back focal length. Targets for testing lenses of long focal lengths may be readily interchanged in a rotatable metal holder. Positions of all component parts of projector may be independently adjusted for maximum performance.—*Bausch & Lomb Optical Co., 625 St. Paul St., Rochester 2, N. Y.*

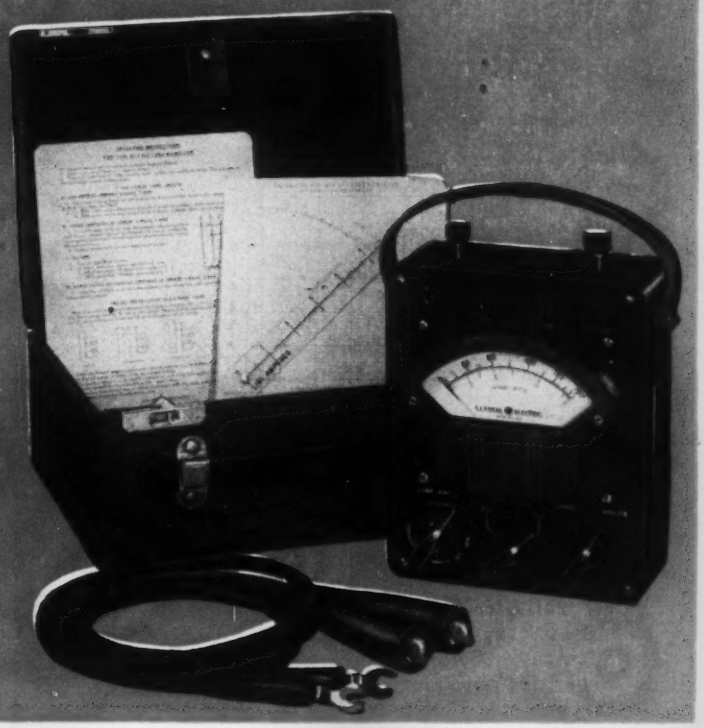
Please mention number 503 when filling out card

Laminated Materials Bonding Tester

New "Aminco Bondimeter" is for detecting faulty bonding of flat laminated materials such as plywood veneers, metal-plastic "sandwiches" and laminated plastics in research, production testing, and inspection. It consists of a hollow aluminum cylinder with a transparent plastic window at top and an open bottom, forming an inverted cup. Inside cylinder is a dial gage with its stem resting against surface of test specimen. A valve automatically maintains a constant difference between pressures inside and outside cup. In operation, "Bondimeter" is placed on surface of speci-

Presenting

THE NEW A-C LOAD VISUALIZER



A COMPACT, PORTABLE SET FOR MEASURING A-C POWER

Here's a new indicating device created by General Electric to meet industry's need for a small, lightweight, low-cost analyzer. Employing an advanced principle of instrument design, it permits all readings to be made on a single scale. Easy to operate and having a wide range of usefulness, this versatile instrument requires only a few simple, convenient connections.

5 INSTRUMENTS IN ONE

Besides serving as a standard 0-2.5/5-amp ammeter and a 0-150/300/600-v voltmeter—or with conventional instrument transformers to extend the range—this instrument can be used, with the aid of the calculator provided, to determine quickly and easily watts, vars, and power factor for load surveys, induction motor tests, reactive-power studies, and power-factor improvement programs.

This handy instrument comes complete with instruction card, calculator, and flexible voltage leads, all enclosed in a sturdy carrying case. Total weight only five pounds. For additional information, write for Bulletin GEA-4784. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

PRICE $97.50

THIS LINE OF GENERAL ELECTRIC PORTABLES INCLUDES:

CF — INKLESS RECORDER

INK RECORDER — CD

AK-1 — A-C HOOK-ON VOLT-AMMETER

A-C VOLT-WATTMETER — AP-9

GENERAL ELECTRIC

602-108

CLIP AND MAIL THIS COUPON TODAY

Yes, I need one of your new A-C Load Visualizer sets immediately. Enclosed is my order, with check for $97.50. Ship express collect.

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Mail to: General Electric Company, Instrument Section, 40 Federal Street, West Lynn, Mass.

What's YOUR special battery problem?

Here's another tough one Burgess engineers solved

THE PROBLEM

To build—to rigid physical specifications—a battery of 400 volts for a constantly intermittent drain 24 hours a day and to have a useful life of 1 year.

THE SOLUTION

A compact ruggedly constructed unit 3⅛" x 3⅛" x 6 1/16" equipped with insulated terminals and with an initial voltage of 400. Designed with the type of cells necessary to deliver this continuous service 24 hours per day for one year.

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. . . is at your disposal to provide the battery you need in the quantity you need . . . large or small.

Send for this free check-sheet . . . it enables you to easily and quickly provide Burgess engineers with all information important to design of a battery for your special requirements.

Send for free specification check sheet to help you state your problem —no obligation.

BURGESS
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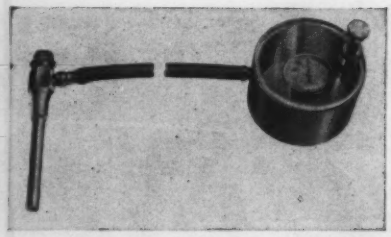
Freeport Illinois

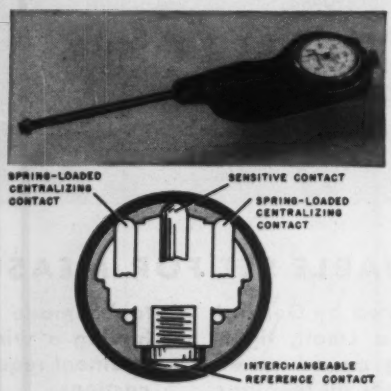


men; cup is evacuated by an aspirator; partial vacuum forces specimen into cup; a well-bonded laminated material deflects slightly as shown on dial gage. In a faulty bonding, however, air trapped between laminations forces laminations apart and into cup; large deflection indicates poor bonding. — *American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.*

Please mention number 505 when filling out card

Small-hole Indicating Gage

New "Model 1204 Small Hole Gage" reads I.D's in ten-thousandths between 0.250" and 0.500", is of self-centralizing

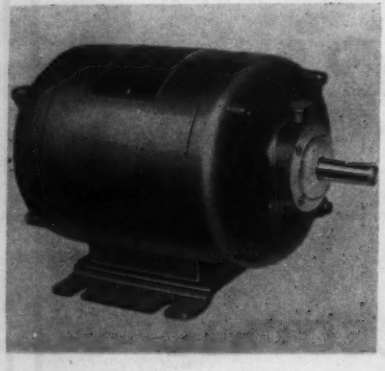


design, employs fourteen interchangeable extensions to cover full range from ¼" to ½", explores any hole within its capacity to a maximum depth of 2¼", revealing diameter and also roundness, taper, bellmouth, and other hole inaccuracies. — *Federal Products Corp., 1144 Eddy St., Providence 1, R. I.*

Please mention number 506 when filling out card

Instrument Motors

New "29 Size" synchronous capacitor-type motors can be supplied in ratings of 1/100, 1/75 and 1/50 hp., 1800 r.p.m., 115-volts 60-cycle. Vibration-free performance is claimed. All ratings are ventilated. Motors can be supplied with either permanently-lubricated

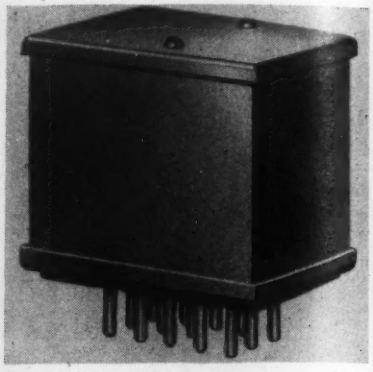


sealed and shielded ball bearings, or large self-lubricating bronze sleeve bearings which withstand heavy or vibrating loads. New "29 Size" is normally supplied as a balanced capacitor start and run motor—essentially a two-phase motor with a uniformly-rotating magnetic field. — *Cyclohm Motor Corp., 5-17 46th Road, Long Island City 1, N. Y.*

Please mention number 507 when filling out card

Rheostatic Voltage Regulator

New "Regohm" is a direct-acting rheostatic type of automatic voltage regulator for a wide variety of appli-

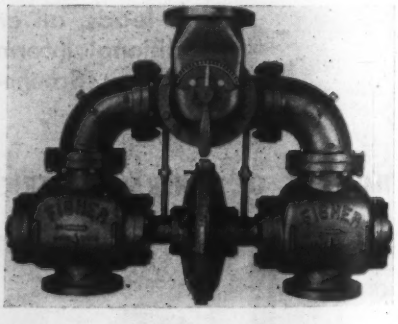


cations. Primary element is a d-c. solenoid coil consuming 1 watt (about 5 watts with voltage-dropping resistor), sensitivity ± 2%. There are ten steps of control resistance at up to 8 watts per step with 80 watts total. Inherent resistance of contacts is 0.1 ohm; maximum current 4 amps. Response is within two cycles. An easily-adjusted dash pot provides stability. Regulator weighs 7 oz., measures 1 3/8" × 1 15/16" × 1 3/4" high (+ 7/16" length of pins), operates in any position, withstands vibration and shock.—*Electric Regulator Corp., 1915 Park Ave., New York 35, N. Y.*

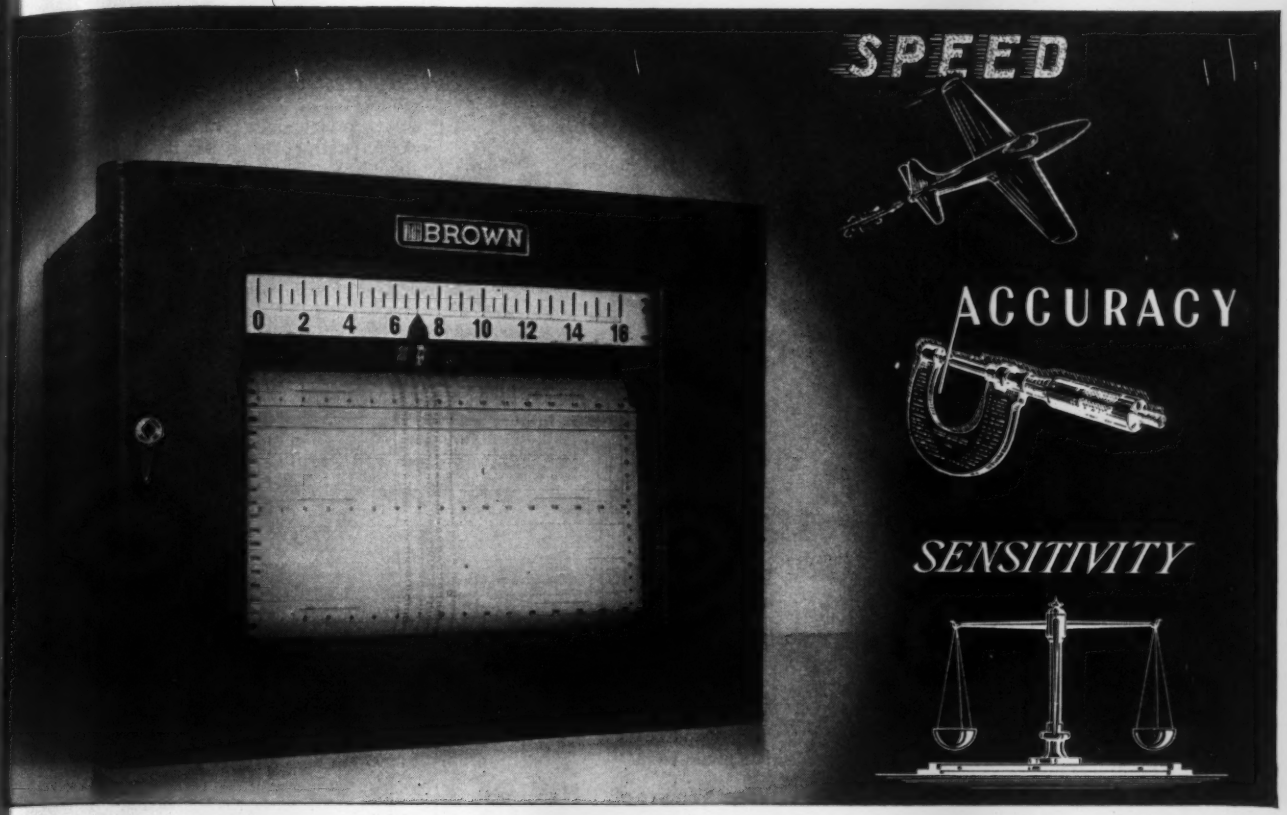
Please mention number 508 when filling out card

Automatic Blending Valve

New "Type 430 Blending Valve" automatically blends two fluids in accurate desired proportion, is particularly de-



signed for processes in petroleum and allied industries. Fluids from two different storage tanks are accurately blended, even though pump or inlet pressures vary. Liquids to be blended are brought to central pressure-equalizing valve, which maintains equal pressure at both inlets of proportioning valve. New device eliminates the necessity of measuring given quantities and



ElectroniK Potentiometers Put THEORIES into PRACTICE

IN the past, advanced processing *theory* developed in the laboratory was handicapped in plant *practice* by the lack of really adequate pyrometer equipment. The Brown ElectroniK Potentiometer hurdled this barrier. Unparalleled accuracy, sensitivity and speed of response have enabled process engineers to *put theories into practice with laboratory accuracy.*

Based on an enviable six year performance record, this instrument is being proclaimed, "The greatest advance in industrial instrumentation since World War I".

ElectroniK Potentiometers are supplied in a wide selection of models both with strip and circular charts and in a large variety of electric and air-operated control forms to fulfill the requirements of any process. Now they are available for 25, as well as 50 or 60 cycle operation.

The Brown ElectroniK Multiple Record High Speed Potentiometer, illustrated above, will record 2 to 16 different temperatures with chart speeds up to 120 inches per hour. The pointer travels full scale in 4½ seconds—balances immediately—prints immediately—then switches to the next point. Minimum printing time between closely spaced points is one second; maximum time between temperature extremes is five seconds.

•

Write today for Catalog 15-8. THE BROWN INSTRUMENT COMPANY, *a division of Minneapolis-Honeywell Regulator Company,* 4482 Wayne Avenue, Philadelphia 44, Pa. Offices in all principal cities.

TORONTO, CANADA — LONDON, ENGLAND
AMSTERDAM, HOLLAND — STOCKHOLM, SWEDEN
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BROWN *ElectroniK* POTENTIOMETERS

HELICOID SCORES AGAIN!

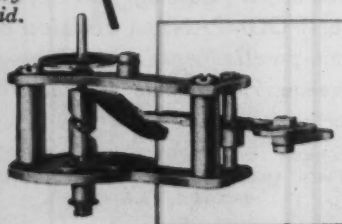
• The new ACALOY case is a high-compression molded aluminum alloy. Treated by a patented process to prevent corrosion. Durable baked-on finish. Withstands 1200 hours salt spray test.

Weather-proof. Neoprene sealing gasket. 18-8 stainless steel snap ring. Greater strength—less weight. It's another Helicoid exclusive.

With back flange for wall mounting, or without flange for stem mounting. Safety blow-out discs optional.

Specify Helicoid gages in the new ACALOY case. They will reduce your maintenance expense. . . . the Helicoid movement, with no gear teeth to wear out, lasts many times longer.

Send for the new catalog that tells the complete story of Helicoid.



Only Helicoid pressure gages have the Helicoid movement.

ACCO

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE
Bridgeport 2, Connecticut

TRADE MARK

batch agitation, reducing blending process expense. Pointer and "0-100" scale device afford a simple method of accurately controlling percentage of inlet fluids to be blended. Capacities: 30 to 900 g.p.m.; sizes: 3" and 6" only; pressure rating: 3", 100 lbs./in.^{2}; 6", 150 lbs./in.^{2}.—*Fisher Governor Co., Marshalltown, Iowa.*

Please mention number 509 when filling out card

Automatic Inspector-classifier for Pistons

New "Airlectric Multicheck" combines automatic inspections of critical dimensions of automotive pistons and

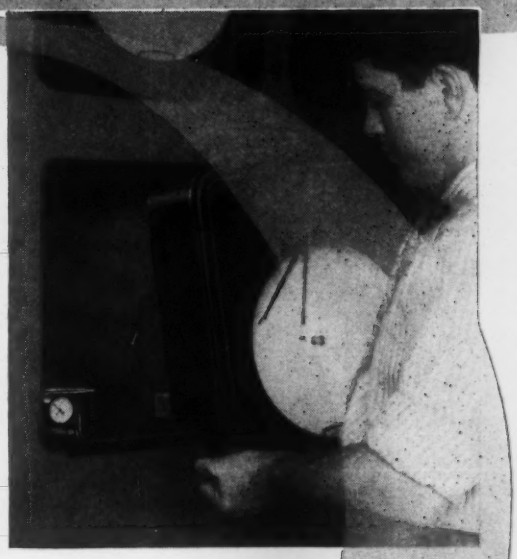
eight classifications. Operator merely loads and unloads pistons. Rate of inspection and selection is between 500 and 700 pistons per hour. Simultaneous automatic measurements are: average diameter of pin holes at each of two bearings, diameters of four ring grooves, widths of five ring grooves and diameter of bottom skirt—a total of twelve. In addition, three classifications of pistons are automatically made on basis of average diameter of pin hole; and five classifications on basis of bottom skirt diameter. Classes are automatically color-stamped—*The Sheffield Corp., Dayton 1, Ohio.*

Please mention number 510 when filling out card

Hand Tachometer

New "Type 25C" hand tachometer is similar in appearance to "Type 25A" described in *Instruments* Dec. 1945, page 922, and "Type 25B" *(Instruments,* Nov. 1946 page 694) but has higher accuracy: 0.5% or better and has a single-speed measuring range of 110 to 210 rpm. full scale. Other speed

THIS CONTROLLER IS EVEN EMERGENCY-PROOFED

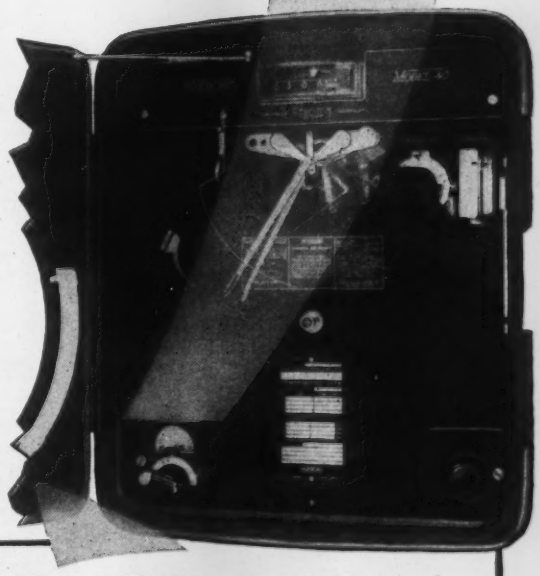


New M-40 has detachable unit that gives independent manual control, "bumpless" transfers

IMPROVEMENTS designed into the new Foxboro M-40 Controller don't stop at laboratory refinements. In every last detail, this instrument is engineered to improve, not only *end results* of processes, but also convenience for the operator.

An outstanding example is the exclusive Manual Control Sub-Panel which is a detachable sub-assembly. It permits permanent hook-up of all panel connections with full manual control facilities *before the complete instrument is mounted* . . . and may be left on the panel to carry on manual control in emergencies, when the Controller is removed.

The "heart" of this unique Sub-Panel is a completely redesigned 4-position Transfer Switch that provides instant switching without any tricky equalizing of gauge readings . . . without slightest "bumping" of the valves.



Detailed description of this and many other radically improved features of the new M-40 Controller are available in Bulletin 381. Write **The Foxboro Company, 46 Neponset Ave., Foxboro, Mass., U. S. A.**

4-Position Switching on Sub-Panel

1 AUTOMATIC POSITION—for normal operation.

2 MANUAL POSITION—for convenience in starting-up, or any emergency requiring manual control. Provides instant return to automatic without "bumping" the process.

3 SERVICE POSITION—permits mechanical servicing, or even complete removal of Controller, with manual control maintained.

4 TEST POSITION—permits complete check of controller mechanism without disturbing manual control.

FOXBORO Reg. U. S. Pat. Off.

M-40 CONTROLLER

The Only Controller with *Permaligned* Construction

PHOTOGRAPHIC EQUIPMENT
for your
RESEARCH AND LABORATORY DEPARTMENTS

SOLAR AUTOFOCUS ENLARGER
SOLAR 5x7 ENLARGER
GROVER CAMERA
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VIEWLEX PROJECTOR
LENSES—All Types
PRINT DRYERS
DEVELOPING TANK
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EVERYTHING YOU NEED
CAMERAS • LENSES • ENLARGERS
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Tell us your needs. Descriptive literature will be sent promptly.
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321 So. Wabash 1858 Chicago 4, Ill., U.S.A.

ranges from 10 up to 10,000 rpm. are available where highest speed is about twice lowest speed to be measured.— *Metron Instrument Co., 432 Lincoln St., Denver 9, Col.*

Please mention number 511 when filling out card

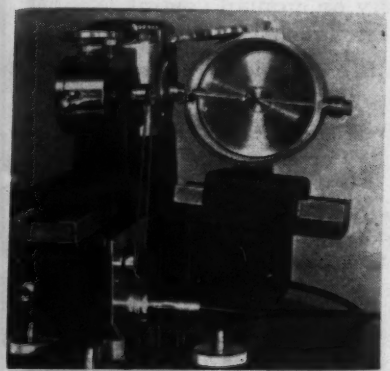
Instrument for Diagnosing Glaucoma

New "Allen Gonioscope" weighs less than 0.1 ounce, permits routine gonioscope examination of the eye, is especially valuable in observing glaucoma but permits other clinical studies such as trauma, inflammatory processes, pigmentary anomalies, etc. Instrument's precision optical prism, held against the eye itself, re-directs light and enables diagnostician, aided by a slit lamp microscope, to see "around" cornea, and into the channels where disease occurs. Prism, mounted in a small plastic speculum, is rotatable to permit examining entire corneal area.— *Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 8, N. Y.*

Please mention number 512 when filling out card

X-ray Diffraction Camera

New high-intensity high-resolution powder camera is said to incorporate advanced features, among which are: (1) slit system said to produce remarkably clean film patterns and reduce exposure time; (2) precise collimator and beam tube alignment; (3) light-tight cover design; (4) universal saddle which adapts camera for use on existing types of x-ray diffraction apparatus made by Philips or other manufacturers. This mount employs new track having rectangular profile with reference and bearing surfaces hard chrome plated to minimize wear and aid in precise repositioning. Mechanical design facilitates rapid vertical translation and pivoting of track, making possible quick and easy camera alignment. A synchronous drive motor (1 rpm.) is incorporated in new mount assembly. — *North American Philips Co., Inc., 100 E. 42nd St., New York 17, N. Y.*



Please mention number 513 when filling out card

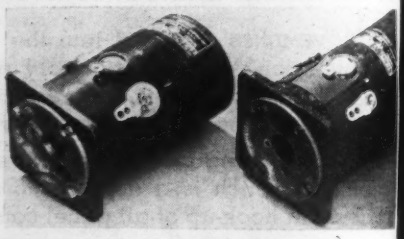
Radar Altimeter Switch

New "Type AVA-68" electrically-operated coaxial-transfer d-p. d-t. switch, said to be the first one of its kind to be produced for use with radar type altimeters, makes possible the use of a single pair of antennas for operation of two radar altimeters. It can be operated from any remote position in aircraft; a two-wire cable connects it to a toggle switch in cockpit. A flip of toggle switch causes the rotor mechanism in transfer switch to make electrical connection between antennas and desired altimeter. Simultaneously, unused altimeter is turned off automatically. UHF portions of switch contacts are of a snap-action, wiping type with corrosion-free surfaces. New switch can also be used for any other electronic equipment which employs a 52-ohm coaxial line. — *Engineering Products Dept., Victor Div., Radio Corp. of America, Camden, N. J.*

Please mention number 514 when filling out card

Servomotors

New servomotors, of either ½" or 1" corestack, are designed for thyratron control operation from 115-volt 60- or 400-cycle a.c. Both feature 72-to-1 built-in gear reduction, armature resistance of approx. 100 ohms, and field excitation of 28-volt d-c. Torque output at approx. 150 rpm. of the ½" type is 60 inch-ounce; 1" type, 150 inch-ounce. Field current 0.15 and 0.23 ampere, respectively. Backlash of gear box is "very low." Overall dimensions, 2" × 2" × 3" and 2" × 2" × 3½". Weight including gear train, < 1 lb. New servomotors are for use in measuring instruments, proportional follow-up systems, computing mechanisms, stabilization systems, etc. Both are available in limited quantities, or on consignment. — *Fairchild Camera and Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y.*



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Electric Heater

New electric heater consists of various metals completely embedded in Pyrex or silica glass. Wire being in intimate contact with the glass over its entire surface, heat transfer is excel-

New Condensed Catalog

- MEASURING SYSTEMS
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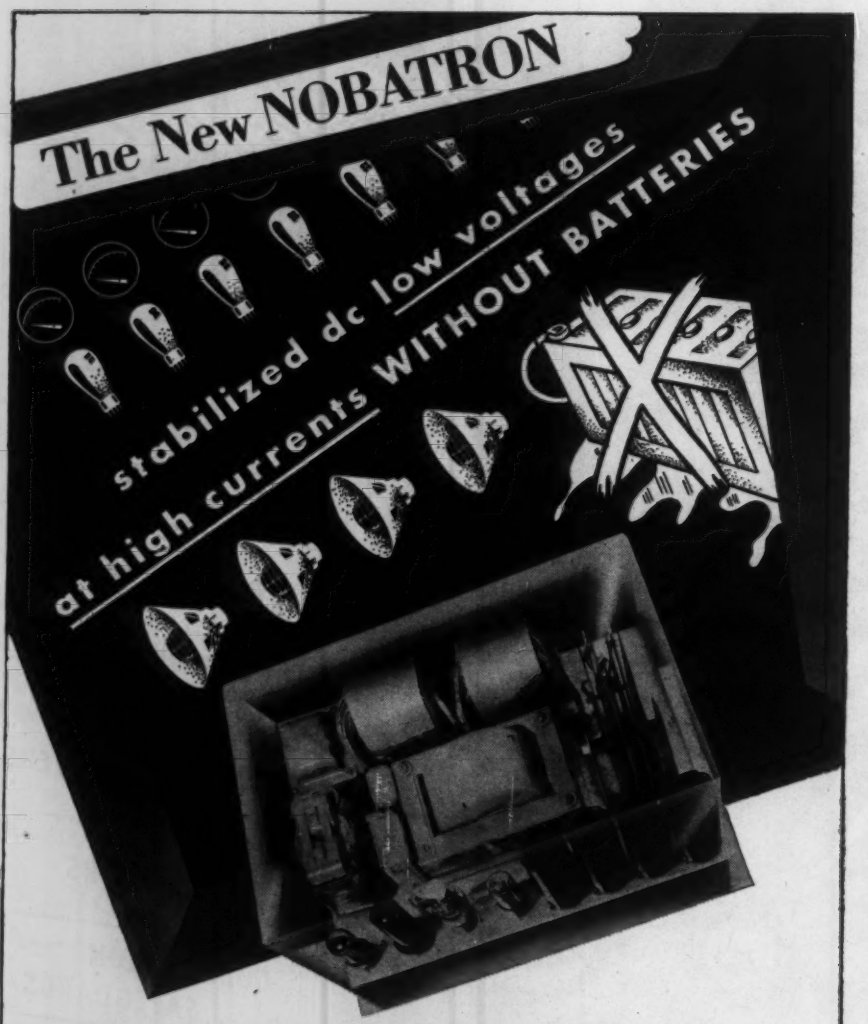

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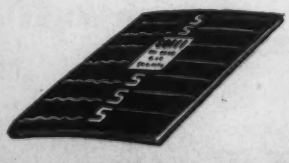
● ***Investigate the many advantages of Sorensen regulators applied to your unit. Write today for your copy of the new complete Sorensen catalog, S-I. It is filled with schematic drawings, performance curves, photos, and contains in detail, "Principles of Operations."***



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A LINE OF STANDARD REGULATORS FOR LOAD RANGES UP TO 30 KVA.
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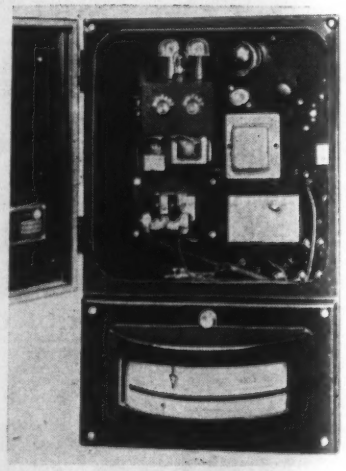
lent. In water, heat output is equivalent to 125 watts/in^2. Heavy metal coatings can be applied to units in various ways. Units can also be inserted into metal tubing and intervening space filled with lead or other metal, so that rate of heat transfer is maintained. Consequently, new units require much less space than conventional ones. Where high resistance to heat shock, corrosion or high temperatures is required silica glass units are recommended. Units can be supplied with vapor-proof rubber-covered connections for service in corrosive atmospheres. They can also be supplied with special terminals as required for various applications. Units are produced for 600 watts at 120 volts and 1200 watts at 240 volts. (Larger or smaller units special). The 600-watt unit has a ½" nominal diameter and immersed portion is 4" long; 1200 watt unit ½" nom. dia. 7" immersion. Overall length of unit can be varied to suit mountings. Heater wire being completely embedded in glass and rigidly held in place, it is thoroughly protected from corrosion, oxidation or breakage due to expansion or contraction. Pyrex heaters can be safely used up to a heated temperature of 1000°F.; silica glass units 1600°F. and higher. Applications include injection molding machines, molding press platens and pewter or lead melting pots. Bare glass unit being corrosive proof is ideally suited for heating liquids in laboratories, hospitals, etc.; for fractionating or other types of stills; air heaters; built-in uses in molding equipment, flash boilers, water heaters, etc.; also as an excellent infrared radiator.—*Thermolettor Products, 95 Broad St., New York 4, N. Y.*

Please mention number 516 when filling out card

Automatic Temperature Controller

New "Xactline Capacitrol" combines features of Claud S. Gordon Co.'s "Xactline Control Unit" and Wheelco



Instrument Co.'s "Capacitrol." Principal features of "Xactline" are said to be: "anticipating" factor which holds temperature tolerances as close as ± 1/5°F. and power "on-off" cycles as short as 3 seconds, positive electrical action, simple adjustment for wide-range control requirements. For "Capacitrol": electronic control prin-

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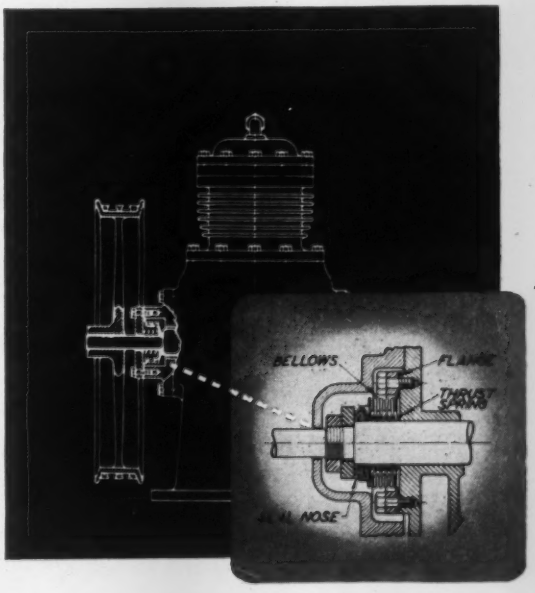

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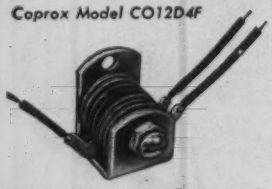

IDEAL FOR AUTOMATIC CURRENT CONTROL

"Coprox" rectifiers may be your answer to more efficient current control. Their varistor characteristics make them ideal for automatic current valving, current limiting, current blocking, as well as current measurement.

Bradley rectifiers are designed to give you trouble-free service. Their electrical characteristics remain stable indefinitely. When operated within normal rating, their life is unlimited.

Send for curves showing current, voltage, resistance and temperature characteristics of Bradley copper oxide rectifiers.

Illustrated literature, available on request, shows more models of copper oxide rectifiers, plus a line of selenium rectifiers and photocells. Write for "The Bradley Line."

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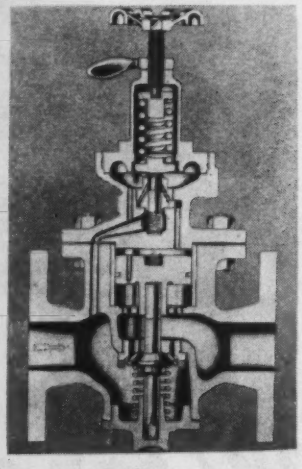
82 Meadow St. New Haven 10, Conn.

ciple, instantaneous control action, direct-reading indicating scale, separately-enclosed measuring instrument, and interchangeable unit construction. —*Claude S. Gordon Company, 3000 S. Wallace Street, Chicago 16, Ill.*

Please mention number 517 when filling out card

Overflow Valve

New "Class UL" throttling type unloading valve for use with steam, air or gas is applicable wherever a



throttling type regulating valve is required to maintain a constant inlet pressure by relieving the excess to a lower pressure system. Smooth throttling control during entire cycle of operation, and with quick action under sudden pressure variations, are claimed. Construction features include renewable wearing parts, hardened stainless steel main and controlling valves, corrosion-resistant piston rings, phosphor bronze diaphragm. Available in sizes from ½" to 4"; for inlet pressures from 25 to 300 lbs./in.², inlet temperature to 550°F. and pressure difference not less than 15 lbs./in.².—*Leslie Co., 225 Delafield Avenue, yndhurst, N. J.*

Please mention number 518 when filling out card

Underground Gas-leak Locator

"M-5 Vapotester" is a self-contained portable gas detector operating on standard flashlight batteries, for locating leaks in underground gas mains and service lines. It quickly reads concentrations up to 100% gas on a three-range scale, "A," "B," and "C." Illustration shows switch at right lettered "C," "CHECK" and "A-B." When testing bar holes, switch is first positioned at "C" to read on "C" scale (higher concentrations). If there is no reading on "B" scale, dilution valve is closed and "A" scale readings are taken. It is stated that highest point of concentration, as taken from log of bar hole readings, is point nearest gas leak, thus preventing loss of time and labor in unnecessary digging.—*Davis Emergency Equipment Co., Inc., 80 Hallock St., Newark 4, N. J.*

Please mention number 519 when filling out card

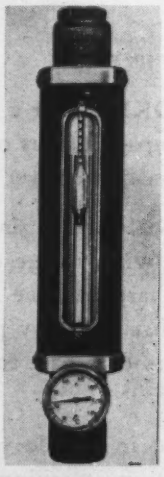
Pyrosensitive Recorder Paper

New "Pyrochrome" is a heat-sensitive, chemically-treated paper for direct-recording instruments. Coating is white, non-granular, abrasion-resistant, unchanged by direct sunlight, unaffected by moisture, electrically non-conductive. Record is produced by an artificial-sapphire stylus heated by a Nichrome wire (2.5 to 3.5 volts required). Various stylus assemblies are available, all with unexposed wires, some with internal wires, weights 15 to 25 milligrams. Unprinted paper is available in all sizes from 2½" to 12", spooled on cores with ½" or 1" inside diam.; printed paper is slit to size and spooled in lengths from 100 ft. to 1000 ft.; normally packaged in lots of 100 spools.— *Pyro-Sensitive Paper Div., Polychrome Corp., 2 Ashburton Ave., Yonkers 2, N. Y.*

Please mention number 520 when filling out card

Continuous Specific Gravity Indicator

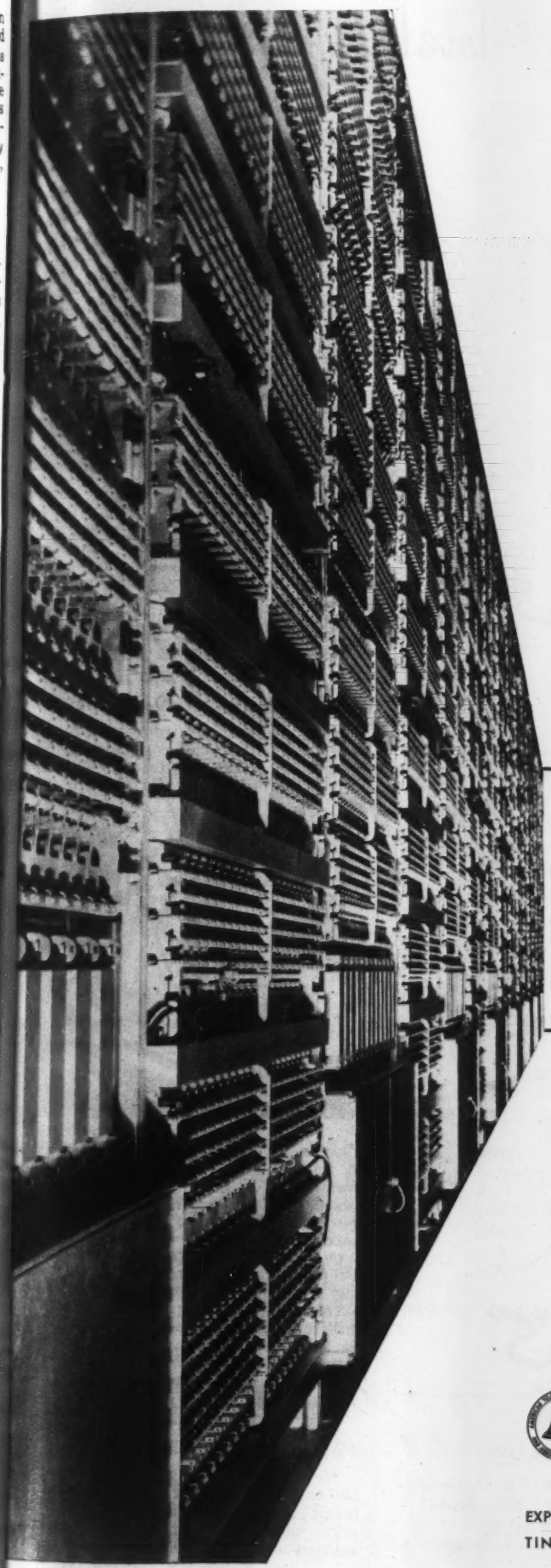
New specific gravity indicator is designed for continuous indication of liquid specific gravity in closed piping systems, particularly in distillation work and in connection with all process systems in which draining of sample batches is considered tedious or hazardous. Instrument is said to be sturdily constructed to withstand very heavy line strain, but at the same time attractive in appearance. Suitable brackets, bezels and lighting accessories are available for adapting instrument for front or rear panel mounting. Standard construction includes carbon steel, bronze, stainless steel or Hastelloy. Needle control valves, thermometers and hydrometers are built into unit. High visibility of hydrometer and thermometer scales is claimed.—*Fischer & Porter Co., Dep't 5C-B, Hatboro, Pa.*



Please mention number 521 when filling out card

Course-plotting Tape for Aircraft Navigation

New "Grimes Navigation Tape" is transparent, ½" wide, is applied easily to aeronautical charts for course plotting, has a line down center to show pilot's course. Cross-lines and numbers indicate miles flown from starting point and in reverse for return trip. Two types: for Sectional Charts (scale of 1 to 500,000) and for World Charts (1 to 1,000,000). Tape adheres



WHEN you spin the dial of the latest type of telephone system—known as "common control switching"—you order into action a giant nervous system. It sends electrical impulses through an intricate maze of circuits: more than 10,000 contacts can be opened or closed in a single dial call.

This system takes your order, remembers it, translates it into its own electrical language, throws out sensitive "feelers" to find a through route, plans how to make the connections, makes them, puts through the call—and, if the preferred paths are busy, finds an alternate route to take the call.

The complex art of telephone switching is brought to a high state of development at Bell Laboratories to serve the Bell System. Some day through "common control switching" a dial in San Francisco may set up a connection through to a subscriber in New York.

■

Left: Backstage on your dial telephone call — some equipment in a typical "common control switching" office.

Bell Telephone Laboratories

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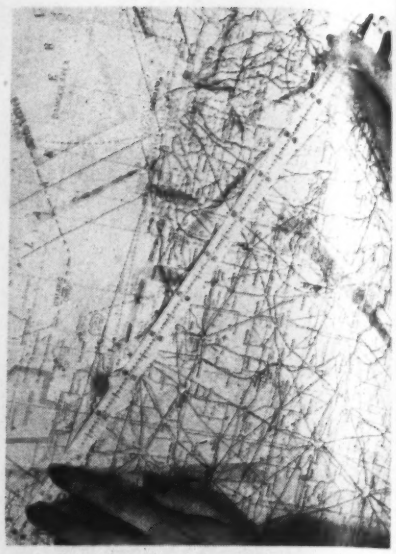
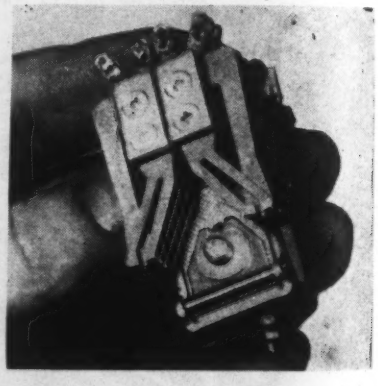


to chart; is not obliterated for future use. Many courses may be plotted on the same chart. Tape strengthens chart, which folds readily. Each roll is packed in metal container, enough tape per roll to plot 2,000 miles of flight with Sectional Chart tape and 4,000 miles with World Chart tape.—*Grimes Mfg. Co., Urbana, Ohio.*

Please mention number 522 when filling out card

Twin-contact D-c. Relay

New "Type J" d-c. relay said to combine best features of conventional telephone-type relay with small size and light weight of aircraft relays is 2¼" long and weighs 2½ oz. Feature is use of independent twin contacts whereby possibility of contact failure is minimized. Palladium-material contacts, of dome-and-disk type, are rated 4 amperes, 150 watts. Other feature: hinge type armature bearing of entirely new design providing largest possible bearing surface. "Type J" is designed for extremely fast operation—one to two milliseconds. Maximum of ten springs on a single-arm relay, 20 on a double-arm relay.—*C. P. Clare Co., 4719 West Sunnyside Ave., Chicago 30, Illinois.*



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Midget Relay

New "Series 600" relay is claimed to be capable of performance equal to many larger and more expensive relays; can be furnished with numerous contact switch combinations up to and

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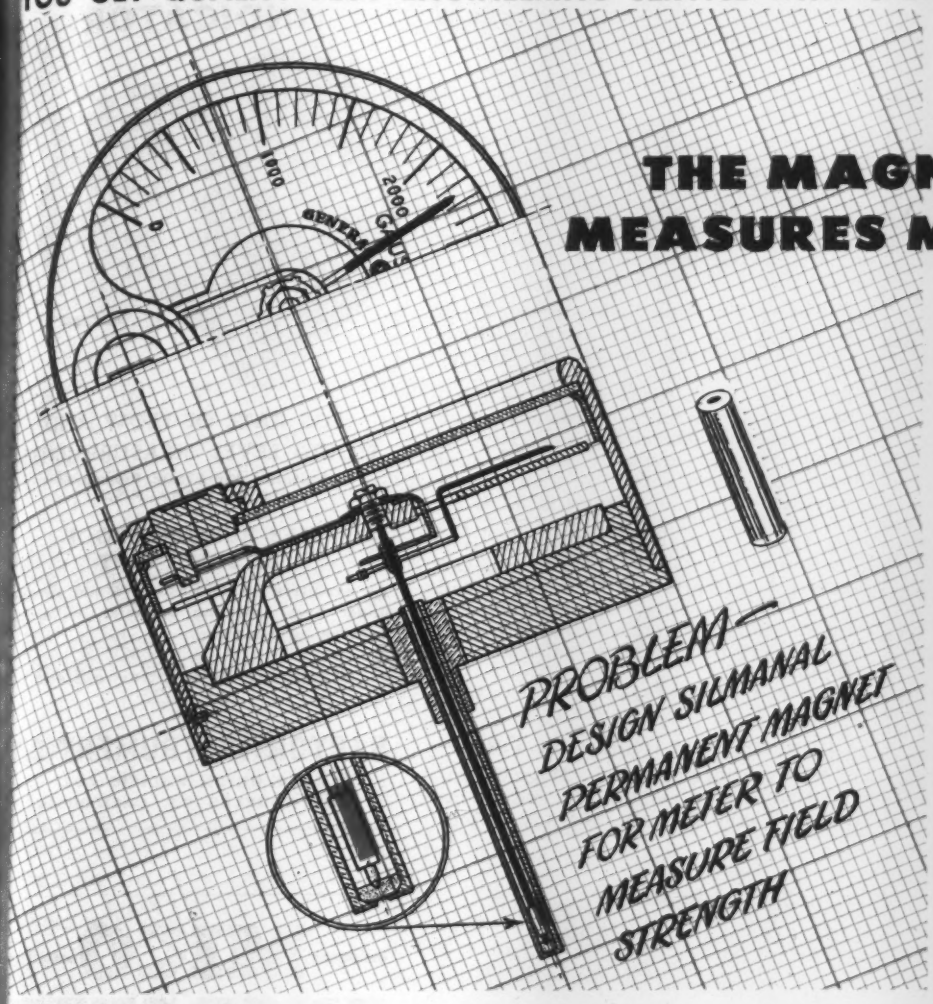

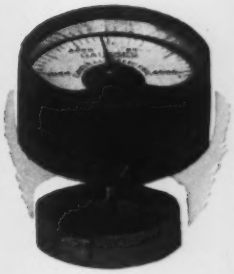

A tiny SILMANAL cylinder magnetized along a diameter is the heart of the G-E gauss meter. When the probe is placed in the field of a permanent magnet or a d-c electromagnet, the SILMANAL magnet on the shaft tends to line up with the flux. Flux density is measured by rotating the instrument until the pointer reaches its highest reading. This occurs when the probe-magnet flux is at right angles to the flux being investigated. The pointer when at zero scale position indicates flux direction.

Augmenting the many grades of sintered and cast ALNICO permanent magnets, four additional General Electric alloys —SILMANAL, CUNIFE, CUNICO, and VECTOLITE —now greatly extend magnet design possibilities.

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VECTOLITE, a sintered non-metallic mixture of iron and cobalt oxides, is amazingly lightweight. Because of its high electrical resistance, high coercive force and low eddy current loss, VECTOLITE has been used widely for rotor magnets.

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PERMANENT MAGNETS

GENERAL ELECTRIC

CD47-JA4

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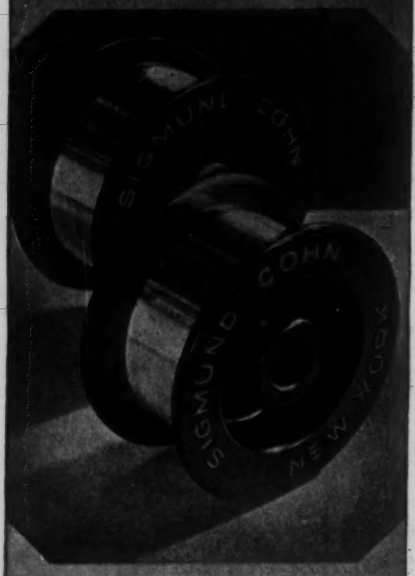

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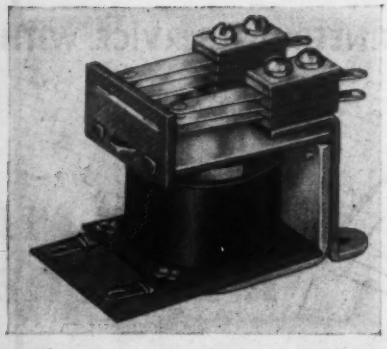

including four-pole double-throw. Short contact blades in switch assembly eliminate intermittent contact or contact "bounce." Dimensions: 1⅛" wide, 2⅛" long, 1½" high. Relay comprises a coil assembly and a contact assembly. Each basic part is interchangeable. For example, contact assembly can be used with any "Series 600" or "605" coils whether operating voltage is 3, 6, 12, 18, 24, 32, 50, 115, 230 a-c. or 3, 6, 12; 18, 24, 32, 50, 110 d.c. Maximum contact current capacity is 8 amperes and power consumption is 6 v.a. Relay will pass Underwriters' specifications. — *Dept. 600, Guardian Electric Mfg. Co., 1638 West Walnut Street, Chicago 12, Illinois.*

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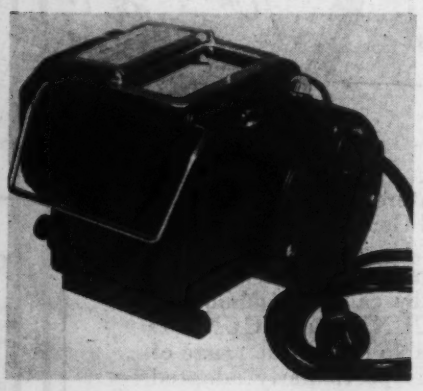
Plug-in Type Insulation Tester

New rectifier-operated "Megger" Insulation Tester can be plugged in instead of hand cranked, is ready for op-



eration by connecting to 115 volts a.c., is especially useful where a large number of tests are to be made at one time or where an individual test is continued for many minutes (dielectric absorption tests where careful observations of insulation resistance are made over a period of ten or more minutes). Power pack consists of a constant-potential step-up transformer and selenium rectifier giving a constant d-c. test voltage. "Megger" ohmmeter covers a wide range and is independent of applied voltage. Ratings are available up to 2000 megohms and 1000 volts.—*James G. Biddle Co., 1211 Arch St., Philadelphia 7, Penna.*

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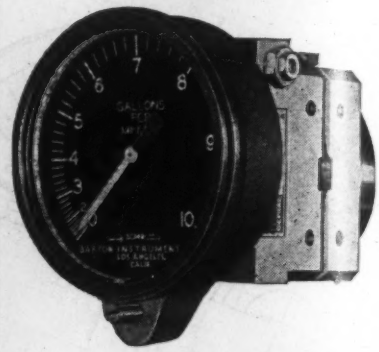
Carbon Monoxide Indicator

New "N.B.S. Carbon Monoxide Indicator" is authorized commercial model of device developed and manufactured during the war by the National Bureau

Differential Pressure INDICATOR



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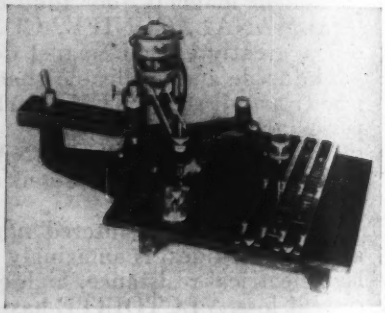

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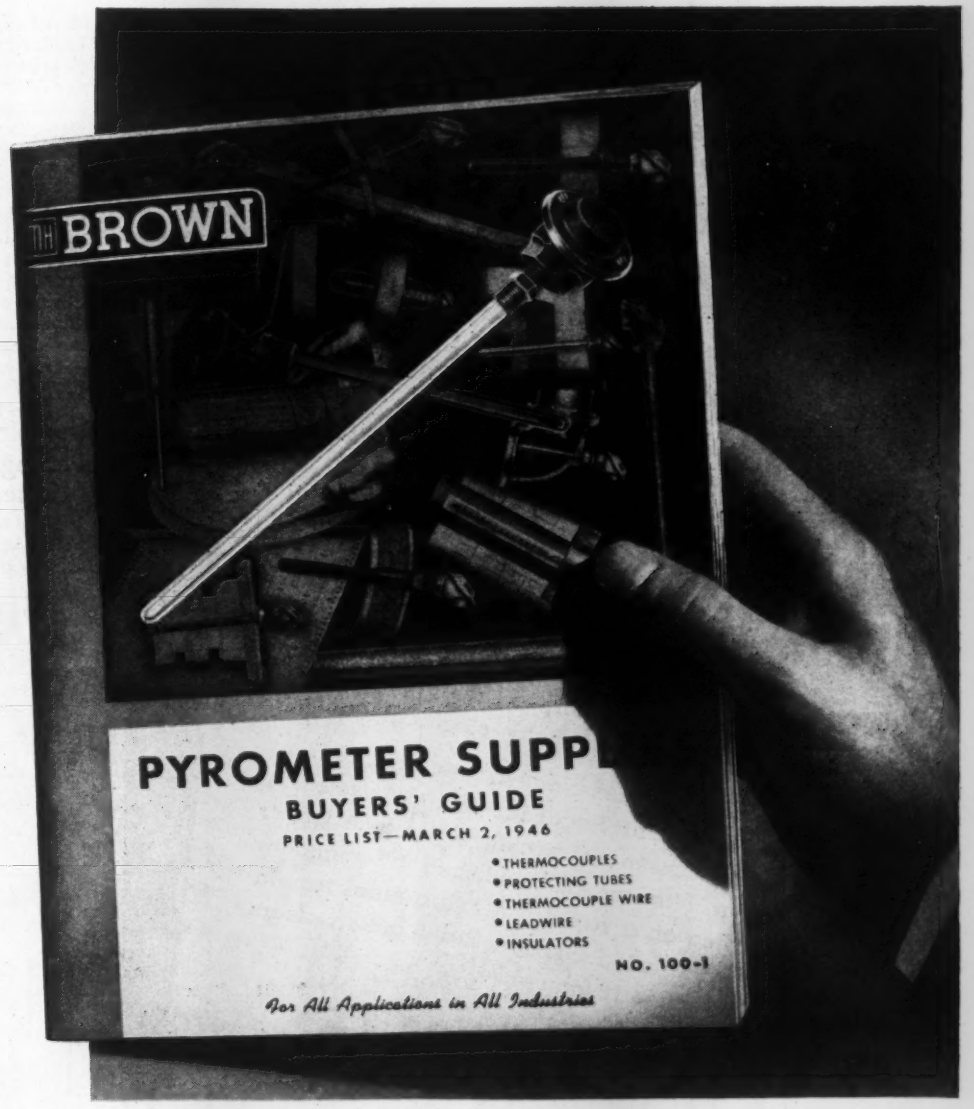

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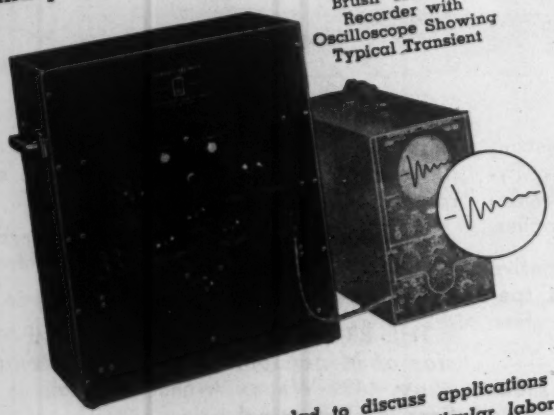
Brush Transient Recorder

automatically records transient phenomena of less than 2/10 second duration—either electrical or capable of being picked up by electrical gauges.

Some typical phenomena which are recorded by the Brush Transient Recorder include explosion waves, light flashes, arc discharges, impact loads, etc. These results are accomplished by magnetically recording on a rapidly moving steel tape a frequency modulated carrier. Reset button clears tape and prepares it for re-use.



Brush Transient Recorder with Oscilloscope Showing Typical Transient

Brush representatives will be glad to discuss applications of this instrument in solving your particular laboratory or production problems. For complete details write today for technical bulletins.

The Brush Development Co. 3419 PERKINS AVE. Cleveland 14, Ohio

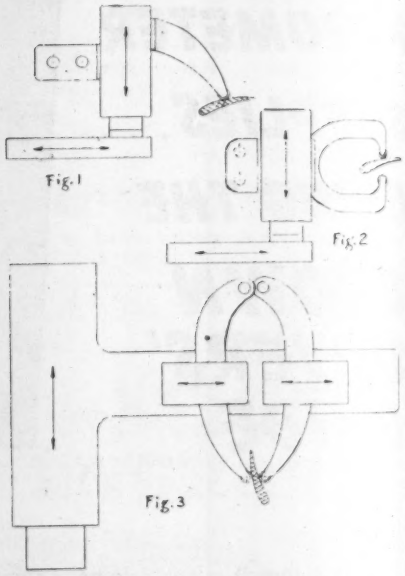
Canadian Representatives: A. C. Wickman, (Canada) Ltd., P. O. Box 9, Station N, Toronto 14

of Standards (see *Instruments*, Dec. 1946, pages 732-733). It will detect and closely estimate less than 1 part of CO per 500 million parts of air. Untrained personnel can obtain reliable results. Detector consists of a small glass tube sealed at both ends and a rubber bulb, packed into a pocket kit. When presence of CO is suspected, kit is opened, tip broken off a small tube and one end inserted in bulb to draw air sample through chemicals in tube. If CO is present, yellow chemicals will turn green in thirty seconds, shade of green depending on concentration. A matching color chart indicates concentration. —*United States Safety Service Co., 1215 McGee St., Kansas City, Mo.*

Please mention number 526 when filling out card

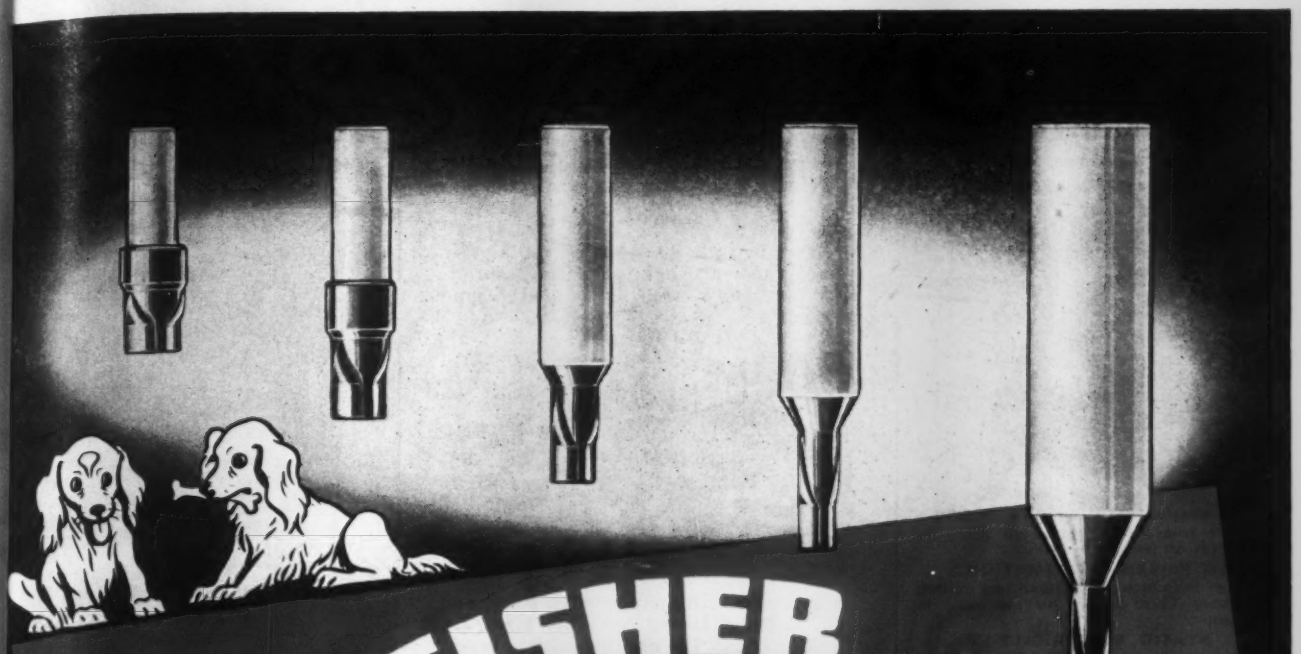
Pantograph System for Projecting Mid-section and Cavity Contours

New "Pant-O-Jector" System comprises (1) staging fixtures for use on stages of standard optical comparators



with 14" or larger screens, (2) coördinated chart-gages on glass, (3) special service when desired. Fixtures available in numerous sizes and forms; Figs. 1, 2 and 3 showing three self-explanatory examples (essential parts only) and Fig. 4 showing a "Pant-O-Jector" unit for checking simultaneously both sides of a turbine or compressor blade. System makes possible for the first time 100% inspection of mid-section

Fig. 4



FISHER
PRECISION CAST STELLITE MICRO-FLUTE
PUP
PROPORTIONAL UNIFORM PERCENTAGE
Inner Valves

Fisher now has available Micro-Flute Pups of No. 6 Stellite. The plug end as shown above is solid cast No. 6 Stellite—precision cast by the lost wax method. The high resistance of No. 6 Stellite to erosion and corrosion—higher than any of the austenitic stainless steels—means Stellite Micro-Flute Pups will maintain their percentage flow characteristics even under most severe applications.

The base and seating surface of the ring is Stellite faced.

Solid Stellite plug end is joined to guide member by welding with stainless welding rod. Guide member is joined to stem member in same manner.

Stellite Micro-Flute Pups are available in orifice sizes of ¼", ⅜", ½", ¾", and 1". Applicable to control valve sizes ½" to 2". Bulletin A-100 gives full details. ***Write for your copy today.***

FISHER
GOVERNOR COMPANY
MARSHALLTOWN . . IOWA

RAWSON ELECTROSTATIC VOLTMETERS

Type 518

Now available to 35,000 VOLTS
Measure true R.M.S. values on A.C., no waveform or frequency errors.

NO POWER CONSUMPTION
Leakage resistance greater than one million megohms. These meters may be used to measure

STATIC ELECTRICITY !
Ideal for measuring high voltage power supplies with zero current drain. Rugged, well-damped movement. All elements surrounded by metal shielding for accuracy and safety.

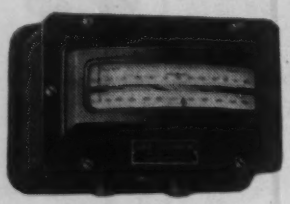
Write for new bulletin.

RAWSON ELECTRICAL INSTRUMENT COMPANY
112 Potter St. Cambridge, Mass.

Representatives
Chicago - New York City - Los Angeles

Wall-Type
INDICATOR PYROMETER

A PRODUCT OF 40 YEARS OF RESEARCH



Model W-1
Switchboard Indicator

Unskilled help may handle this direct-deflection instrument, which needs no manual adjustment. Designed for numerous ranges of temperature, both F. and C.

Write for descriptive Bulletin 400

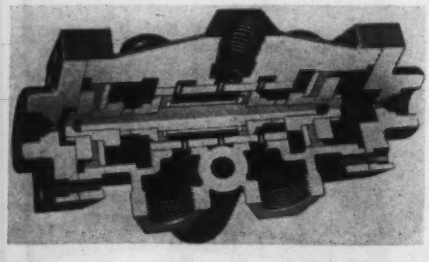
Charles Engelhard, Inc.
233 N.J.R.R. Ave. Newark 5, N. J.

and cavity contours at high speed and low cost (example, 18 dimensions in 15 seconds at 50× magnification, 250 parts per hour).—*Engineers Specialty Division, U.E.& C. Co., 908 Ellicott St., Buffalo 8, N. Y.*

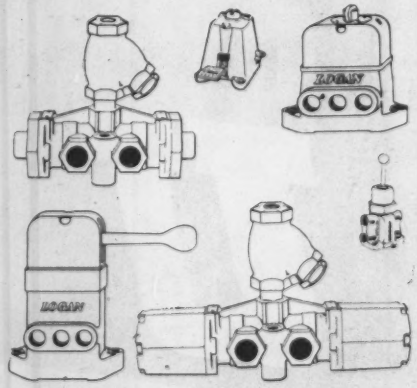
Please mention number 527 when filling out card

Air Control Valves

New air control valves, all completely re-designed, are available in 79 standard models. New sliding piston-type



construction eliminates valve seats and rod packing. Direct operated types include manual (2- and 3-position types, with ball detent or spring return to top, bottom or neutral); toggle; foot; cam; and compact light duty ¼" port 4-way valves operated by push button, toggle, cam or built-in air cylinder. Re-



mote-operated types include Electric (Direct); Bleeder; Pilot Pressure (2- and 3-position types, latter with ports exhausting or blocked in neutral, and returning to neutral by spring or line pressure). Activated by remote 4-way or 3-way pilot operating valves operated by hand, toggle, foot, cam, electric solenoid or built-in air cylinder. Top cover of manual valves can be rotated to place handle in any of four positions at 90° intervals. Parts being interchangeable, valves can be quickly reconverted for other uses. All valves in new line are designed for operation at pressures to 150 lbs./in.².—*Logansport Machine Co., Inc., 905 Center Ave., Logansport, Indiana.*

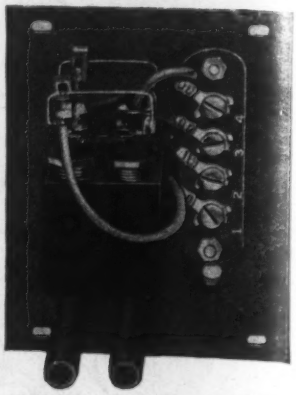
Please mention number 528 when filling out card

Signalling Timer

New "Series S Signalling Timer" closes or opens a circuit at end of interval, operates additional buzzers, bells or lights at remote locations. When pointer is set to desired interval, pilot light goes on and moving pointer rotates anti-clockwise toward zero; when interval is completed, an audible

Engineer your own Gas Synthesis Instruments with

GOW-MAC EVERTITE THERMAL CONDUCTIVITY



Cell Units for Gas Analysis
3" x 4" x 5"

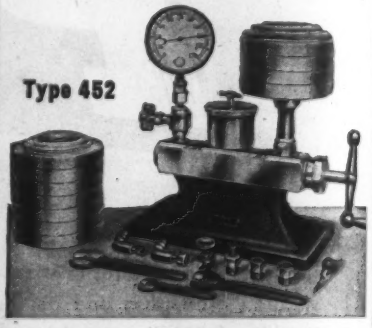
Pressure Tested—No Cements
Diffusion Type—Straight Wire
Panel Mounted or In Housing

Write for Bulletin 41546-MI

GOW-MAC INSTRUMENT COMPANY
22 Lawrence St., Newark 5, N. J.

AMTHOR Dead Weight Pressure Gauge TESTER

Type 452



Modern design and construction puts this rugged precision instrument in a grade above the ordinary dead-weight testers.

Made in ten ranges, to 5000 lbs. maximum.

We guarantee 1/10 of 1 percent accuracy in each range.

The Type 452 is designed for simplicity and compactness. It incorporates the newest refinements and improvements. Adapters and tools are supplied, as well as either carrying case or protecting cover.

Immediate and intelligent attention will be given to your inquiries on all industrial speed measurement problems.

Drop us a line today.

Amthor Testing Instrument Co., Inc.
49a Van Sinderen Ave. Brooklyn, N. Y.

now HAGAN makes

Ring Balance meters

Hagan Corporation has acquired all assets of Ring Balance Instrument Company, Chicago.

Manufacture of the full line of Ring Balance instruments will continue at the company's Chicago plant; the design staff has been retained; but these instruments will now be backed by the material and technological resources of the Hagan Corporation.

Sales and service will be handled by the present representatives of the Ring Balance Company, and by the district offices of Hagan Corporation. All activities will be directed from the Hagan offices in Pittsburgh.

Any of these offices will be glad to give you full information concerning Hagan Ring Balance instruments.

Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN CORPORATION

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BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

a new **CONANT** service

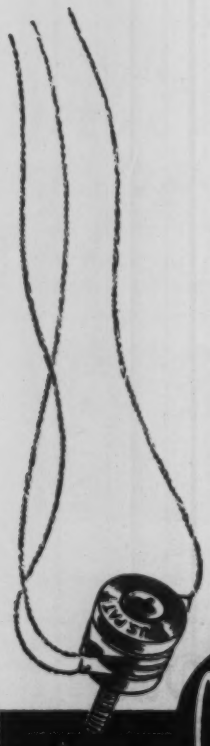
Balanced Inventory Buying

For Rectifier Distributors...

Unbalanced rectifier stock conditions are both annoying *and* costly. Now, however, you can avoid having surplus inventories on some items and "out of stock" entries on others with Conant's new Balanced Inventory Buying plan.

As a result of a study of instrument rectifier sales to test equipment manufacturers, Conant is now able to offer you 3 rectifier package assortments for balanced buying. Whatever your volume of business, one of these assortments will enable you to purchase instrument rectifiers with the assurance that your stock on hand will always be properly proportioned.

Prices of the new "packages" run from $28.78 to $120.48. Send a postcard today for full information about quantity and type of rectifiers in each unit. Reply will be prompt and include a FREE copy of the Conant Instrument Rectifier Replacement Guide . . . the handiest reference book available on replacements for most test equipment.



CONANT *Instrument Rectifiers*

ELECTRICAL LABORATORIES

6500 O STREET, LINCOLN 5, NEBRASKA, U. S. A.

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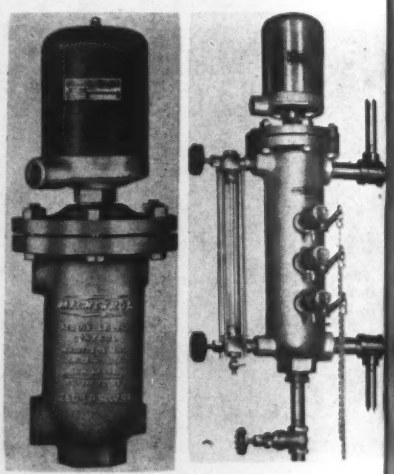
85 E. Gay St., Columbus, Ohio
600 S. Michigan Ave., Chicago 5, Ill.
1215 Harmon Pl., Minneapolis 3, Minn.
518 City Bank Bldg., Kansas City 8, Mo.
1212 Camp St., Dallas 2, Texas
378 Boulevard N. E., Atlanta, Ga.
4018 Greer Ave., St. Louis, Mo.
1526 Ivy St., Denver, Colo.
4214 Country Club Dr., Long Beach 7, Cal.
Export Div., 75 West St., New York 6, N.Y.
50 Yarmouth Rd., Toronto, Canada

alarm sounds and pilot light goes out. Buzzer continues to sound until toggle switch is snapped to "off" or timing interval is again started by moving pointer knob to desired time interval. Rapid resetting of pointer knob, when same time interval is to be repeated indefinitely, is afforded by a quickly adjustable back-stop. Case size 5" × 5" × 3½" deep. Timer operates on 115- or 230-volt 25-, 50- or 60-cycle a.c., voltage and frequency to be specified. Six models are available, maximum intervals 1 min. (1-sec. graduation) to 3 hrs. (5-min. grad.). — *Industrial Timer Corp., 110 Edison Pl., Newark 5, N. J.*

Please mention number 529 when filling out card.

Boiler Water-level Controller and Combination Control

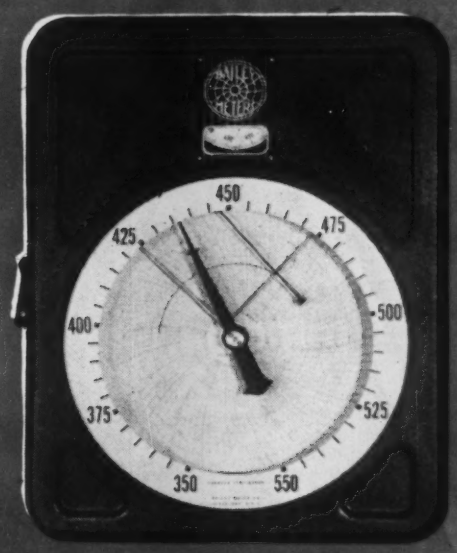
New "Model 126" (125-lb. pressure) and "Model 251" (250-lb.) multi-stage boiler water level controllers provide



through a simple magnetic switching action, pump control, low-water fuel cut-off and low-water alarm. It transmits changes in water level to switching mechanism by magnetic action: no mechanical or electrical connection between pressure chamber and switching mechanism. "Type S Unitary" switching mechanism has mercury switch, magnet, lead wires and terminal strip built into a single unit: simple installation and easy servicing.

New "Model W-126" (125-lb.) and "W-251" (250-lb.) combination boiler water column and controllers combine water column and multi-stage boiler water-level controller in a single unit. Advantages: (1) lower first cost, (2) easier installation, (3) space saving

3 WAYS to CONTROL TEMPERATURE



WITH BAILEY PYROTRON ELECTRONIC RESISTANCE THERMOMETERS

1. FOR AIR-OPERATED SYSTEMS

A free floating air pilot valve actuated by the Pyrotron slidewire unit establishes an air loading pressure for the control of valves and drives. Adjustments and relays provide flexibility of range, sensitivity, and speed of response, as well as reset action, easy coordination with other factors, and remote manual control.

2. FOR ON-OFF ELECTRICAL SYSTEMS

By Electronic Relay—Two slidewires, one set manually to the desired temperature standard by a convenient knob and scale, and the other automatically positioned by the Pyrotron slidewire unit, form a control bridge which operates an electronic relay.

By Electric Contacts — Adjustable cam on Pyrotron slidewire unit operates a totally enclosed snap switch.

3. FOR MODULATED ELECTRONIC SYSTEMS

A control bridge formed by two slidewires establishes a small signal voltage which changes in phase and intensity to operate a standard electronic control unit. The d-c output of this unit is accurately regulated according to the signal and applied to a saturable core reactor to vary voltage on the a-c heating circuit.

UNUSUAL FEATURES OF THE BAILEY PYROTRON ELECTRONIC RESISTANCE THERMOMETER

1. Resists vibration and shock.
2. Needs no careful leveling.
3. Motor drive provides abundant power for operation of recording pen, controller, alarms and signals.
4. Simple a-c measuring bridge needs no battery.
5. Sturdy electronic units keep the bridge in continuous balance and replace the usual galvanometer and its attendant mechanism for step by step balancing.
6. Interchangeability of packaged units simplifies replacement.

For details on this unusual Electronic Resistance Thermometer, which indicates, records and controls temperatures between —100°F. and 1200°F. ask for Bulletin 230-A. P-10

BAILEY METER COMPANY

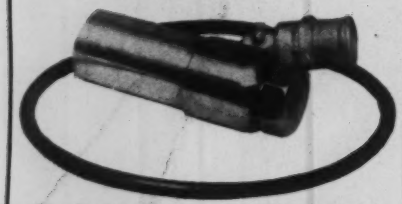
1041 IVANHOE ROAD • • • CLEVELAND 10, OHIO

Controls for Processing

TEMPERATURE FLOW
PRESSURE LEVEL
% OXYGEN DENSITY
% COMBUSTIBLES RATIO

STATHAM
PRESSURE TRANSMITTER

MODEL P 10



The Statham Pressure Transmitter, Model P 10, is designed to provide electrical indication of high gage pressure.

Increased accuracy is combined with the simplicity of operation, ruggedness, small size and light weight which characterize all Statham Instruments.

Specifications:

Ranges: 50 psi to 5000 psi.
Input power requirements: Dry cells, regulated A. C. or carrier.
Output: Sufficient for direct operation of panel type microammeters, recording oscillograph, recording potentiometer, or cathode ray oscilloscope.
Size: 1⅜ x 4 in. Weight: 14 oz.

Statham Laboratories also makes Pressure Transmitters with full ranges as low as ±0.2 psi, accelerometers, and dynamometers. Our engineering department is at your service to analyze your problems and make specific suggestions for solving them. Write for our catalog.

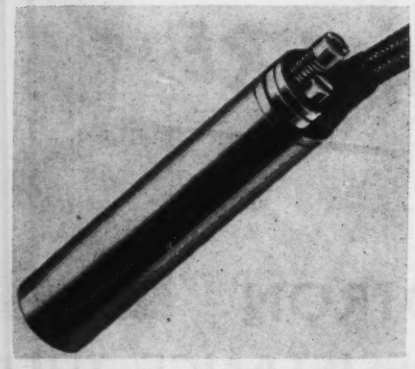
STATHAM LABORATORIES SCIENTIFIC INSTRUMENTS
8222 BEVERLY BOULEVARD
LOS ANGELES 36, CALIF.

(4) more reliability because it eliminates cross-connection piping, and (5) reduction in boiler maintenance because it requires only one blow-down instead of two.—*Magnetrol, Inc., 2110 S. Marshall Blvd., Chicago 23, Illinois.*

Please mention number 530 when filling out card

Differential-expansion Thermostat

New "Scaico" thermostat utilizes expanding-tube principle: consists of a ½" brass or stainless steel tube, 2"



long, in which heavy-duty contacts are carried on low-expansion nickel-iron struts; outer case is temperature-sensitive element and contact action is caused by difference in expansion rate of outer shell and inner struts. Assembly weighs only 1½ oz., is soldered, welded, or riveted: no linkage or pins used. Result is said to be compact and rugged mechanism responsive to a fraction of a degree change in temperature. Various ranges from −100F°. up to 600°F. Adjustment by turning an adjusting screw. Maximum capacity 600 watts. A larger unit, ⅝" dia. × 3" long, has load capacity up to 2500 watts. New thermostat was originally developed for aircraft use because of its small size and weight and freedom from vibration effects, has numerous other fields of application. Small quantities available from stock, reasonable delivery schedules on large orders.—*Smith Control & Instrument Corp., 1329 Highland Ave., Needham 92, Mass.*

Please mention number 531 when filling out card

Resistance Tester

New "Model B-7 Megohmer" combines an insulation tester and ohmmeter, provides two megohm ranges, two ohm ranges and two test potentials for insulation resistance measurements.

HARDNESS TESTING...

done WITH NO METAL HAZARDS. The SCLEROSCOPE has done it for the past 39 years.

In general use for specification purposes. Simple, sturdy. Comparatively inexpensive.

•

Illustrated bulletins free

The Shore Instrument & Mfg. Co., Inc.
9025 Van Wyck Ave., Jamaica 2, N. Y.

Automatic ELECTRIC PRODUCTS

TIME SWITCHES
Ruggedly constructed *Automatic* Switches have visible dial in tamper proof compact cabinet . . . pure silver contacts . . . 2 to 24 "on" and "off" operations. For any load . . . for every installation an *Automatic* time switch or Interval Timer will deliver superior performance.

Synchronous or Manually Wound

FLASHERS
Automatic heavy duty, motor driven Flashers available in circuit arrangements for every conceivable effect. Pure silver contacts. Models for any load or purpose.

Alternates *Chasers* *Spellers*

RELAYS
Automatic manufactures a complete line of dependable relays for industrial, business machines, radio, electronic and many other uses . . . open, or can type with tube-base, plug-in features.

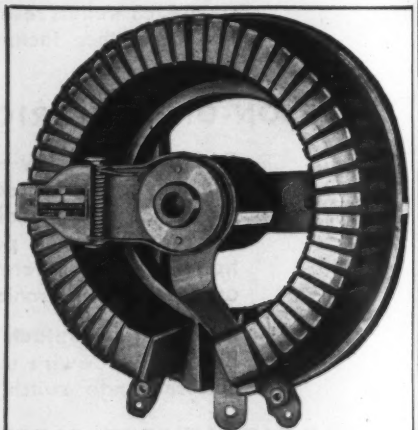
Consult our Engineering Department

WRITE FOR SPECIFICATIONS AND INFORMATION TODAY

In Switches, Flashers and Relays where dependable performance is paramount, look for the "Diamond Seal for Diamond Quality".

WRITE TODAY!

AEMCO *Automatic Electric* MFG. CO.
58 STATE ST., MANKATO, MINNESOTA



A NEW LINE OF
VITREOUS ENAMELED ROUND RHEOSTATS

7 SIZES: From 50 to 500 WATT

SPRING HINGED CONTACT ARM for uniform, unchangeable contact pressure. Easy and smooth to operate.

Request Catalog No. 4

REX RHEOSTAT CO.
BALDWIN, L. I., N. Y.

A quarter in the slot . . . and the hotel radio comes to life. The travel-weary guest can relax with exactly two hours of his favorite music. The control that times the program is operated by a Telechron synchronous electric motor.

This is only one of many applications for Telechron motors. Dependable and versatile, they have been used successfully in clocks and timing devices for 25 years—and more. New and unusual applications to automatic timing, switching, recording and control equipment are being developed constantly. Perhaps a Telechron motor is the answer to your needs.

Telechron motors are easily adapted to a wide variety of electric devices—complicated control mechanisms as well as simple switches. They're self-starting, and reach rated speed almost instantly. They operate in perfect synchronism with all commercial frequencies . . . *can't run faster or slower*. Conservative torque ratings, precision building and Telechron's exclusive oiling system assure long, trouble-free service.

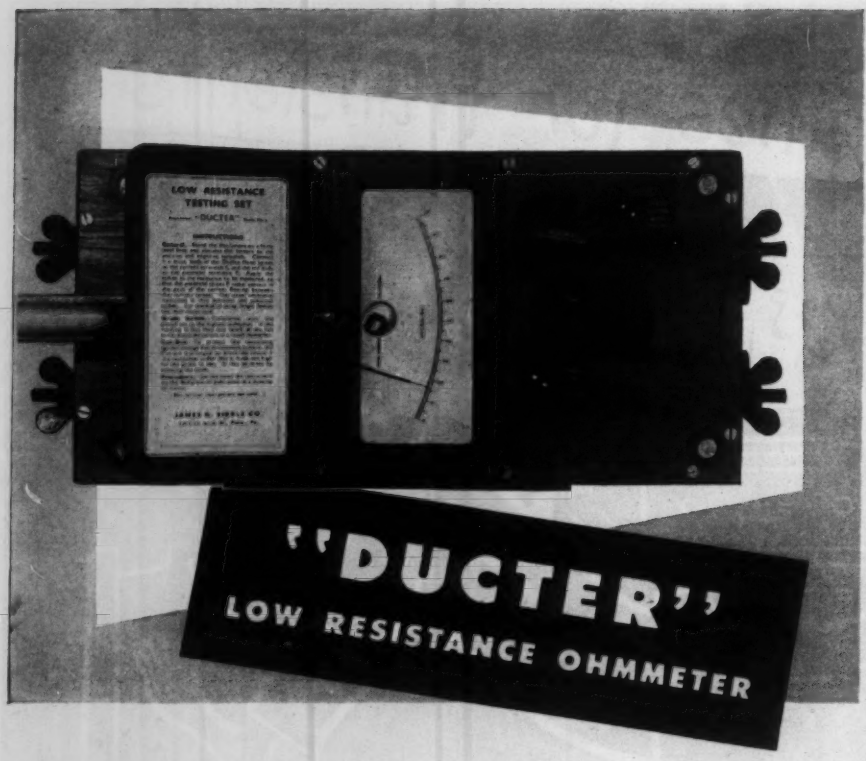
A Telechron motor gives your product the extra sales advantage of Telechron leadership. For over 25 years, Telechron has been the largest producer of synchronous electric motors. Every one is Underwriters Laboratories approved. Why not let Telechron's *application engineers* study your motor needs? They'll be glad to make recommendations. Just address Motor Advisory Service, Dept. B, Telechron Inc., Ashland, Mass.

Telechron Motors Are Now Being Used for:

Stoker, Oil Burner and Temperature Controls
Industrial Process and Cycling Timers
Business Machinery
Medical Devices
Household Appliance Timers
Musical Devices

Telechron
SYNCHRONOUS MOTORS

The First and Favorite Synchronous Electric Timing Motor

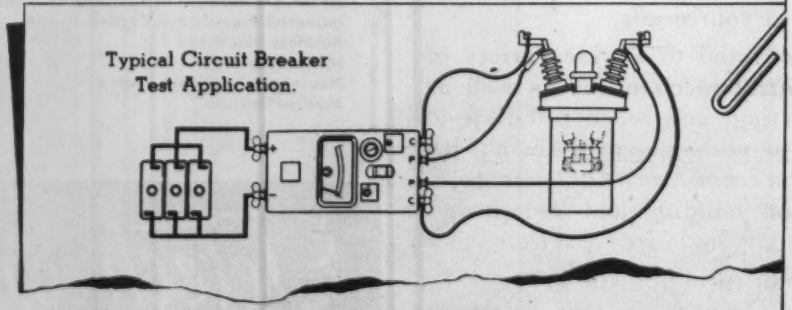


HERE'S a rugged, portable, direct-reading, and yet accurate *field* instrument for measuring resistance down to .000001 ohm (1 microhm) that can be taken right to the job and operated by *one man* simply applying a pair of hand spikes and reading the position of a pointer over a scale.

The "Ducter" Ohmmeter is invaluable for detecting trouble in switches and circuit breakers . . . for measuring any type of low electrical resistance or contact such as armature and transformer windings, soldered joints, etc.

In one operation, the "Ducter" Ohmmeter performs what otherwise requires more complicated equipment as well as both training and practice in low resistance measurement. You'll find the story of this member of the famous "Megger"* family of resistance measuring instruments in your free copy of Bulletin 24-25-I.

*REG. U. S. PAT. OFF.


Typical Circuit Breaker Test Application.

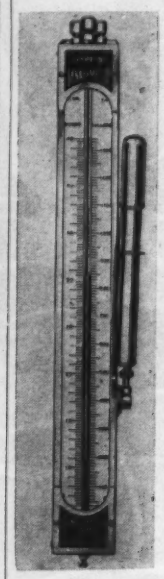
James G. BIDDLE CO.

ELECTRICAL & SCIENTIFIC INSTRUMENTS

1316 ARCH STREET • PHILADELPHIA 7, PENNA.

Feature is unusual readability: on 0-200-ohm scale, for instance, testing to as low as 0.1 ohm is possible. Aggregate megohm scale (dividing point 1 megohm) is close to 5". There are said to be more scale divisions on megohm scale than on any comparable instrument. "Model B-7" employs a vibrator transformer circuit to step up two No. 6 dry cell batteries connected in series to furnish test potentials of 500 and 250 volts d-c. Another feature is ease of changing batteries.—*Herman H. Sticht Co., Inc., 27 Park Place, New York 7, N. Y.*

Please mention number 532 when filling out card



Liquid Level Gages

New "Type S Tank-O-Meter" for measuring contents of tanks at any remote point regardless whether tanks are open, vented, under pressure, or under vacuum, can be furnished with high or low alarm switches for closing or opening any circuit at any predetermined high or low levels. Fifty-two standard models for measuring liquid depths ranging from one foot to seventy-five feet. Can be furnished for hand pump or compressed air operation. — *Uehling Instrument Co., 473 Getty Ave., Paterson 3, N. J.*

Please mention number 533 when filling out card

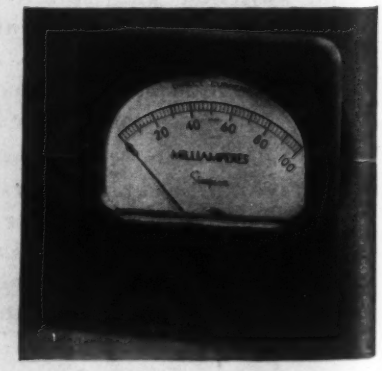
Full-wave CuO Rectifier

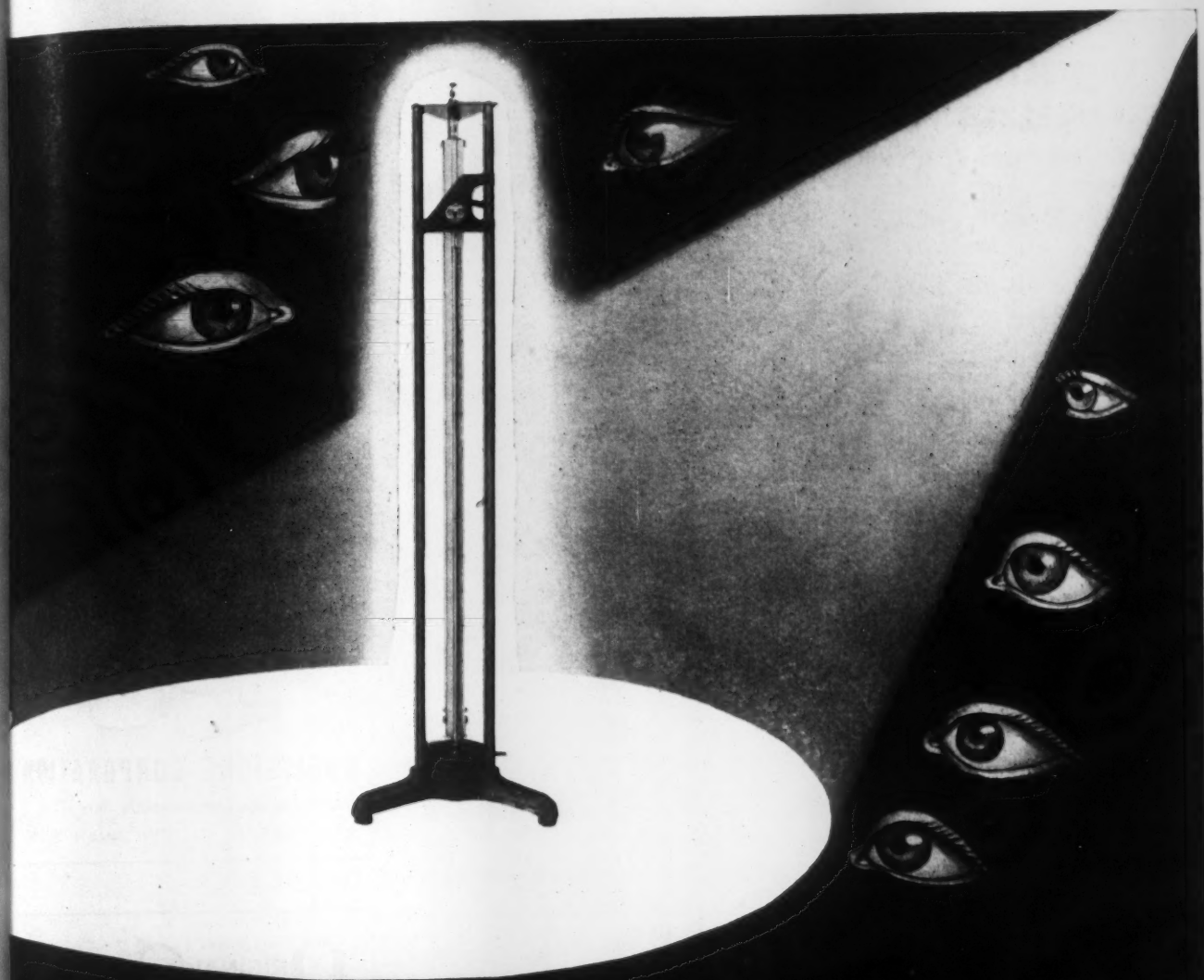
New permanent full-wave copper-oxide rectifier for portable-radio low-voltage battery charging is rated at 1.5 amperes continuous current, is light in weight, rugged, dependable, small in size (a single 2" sq. plate) and with versatile mounting provisions.—*Bradley Laboratories, Inc., 82 Meadow St., New Haven 10, Conn.*

Please mention number 534 when filling out card

Illuminated-dial Electrical Instruments

New method of illumination of instrument faces does away with translucent dials, is said to "flood every fraction of the dial face with an even radiance, doing away completely with shadow spots." A Lucite cone carries light from a recessed bulb in back of instrument through front edge of cone





Anyway you look at it....

—the W & T Mercurial Barometer is a headline performer. Here's why—

1 It can be used with equal ease as an accurate dependable manometer by simply opening a valve.

2 Temperature compensation is accomplished by a twist of a dial.

3 Well level corrections for each reading are eliminated.

4 A magnifying eyepiece minimizes reading errors.

5 The knife-edge float on the mercury column permits readings to 0.005 of an inch of mercury with scales graduated in inches and to 0.1 mm of mercury with scales graduated in millimeters.

6 It can be used for any pressure or vacuum measurement from zero absolute to 31 inches of mercury.

7 The column is made from precision bore tubing to permit interchangeability.

8 It's built throughout to exacting standards for dependability, accuracy and long life and is supplied for either bench or panel mounting.

Write today for detailed information on this versatile precision instrument. A-55

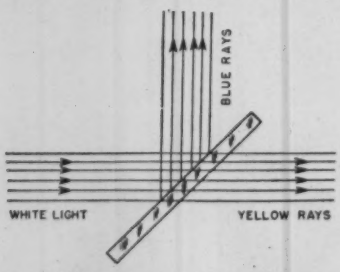
WALLACE & TIERNAN

PRODUCTS, INC.

BELLEVILLE 9 NEW JERSEY

FS MULTI-LAYER INTERFERENCE FILMS

Dichroic & Achromatic Beam Splitters



Chromatic Spectral Selection Effect: a certain portion of the spectrum is reflected, the remainder transmitted.

Achromatic Spectral Selection Effect: the incident light is split into two beams, one reflected, one transmitted, each beam retaining the spectral properties of the original incident beam.

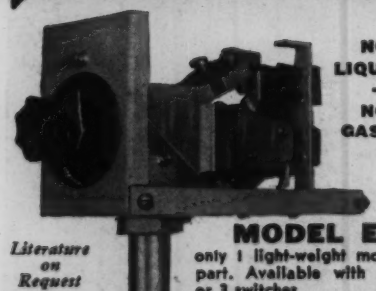
Transmission or reflection peaks as high as 85 to 90% but the spectral bands are relatively broad.

Submit your problems and ask for bulletin MI-318 giving graphs of standard types now available.

FISH-SCHURMAN CORPORATION
230 East 45th St., New York 17, N. Y.

Fish-Schurman

BURLING TEMPERATURE LIMIT SWITCHES



NO LIQUIDS • NO GASES

Literature on Request

MODEL E
only 1 light-weight moving part. Available with 1, 2 or 3 switches.

As a 3 switch model, Burling Model E is recommended for use (a) where load is divided into 3 parts, (b) where 1 switch is used for controlling, one as a high limit, one as a low limit, (c) to give definite stops or position to a 3 or 4 position diaphragm motor, (d) to give 3 speed control of variable speed motor.

Accurate, rugged, dependable. Corrosion and heat resisting tube. Dial pointer for easy setting. Locking screw locks temperature setting. Increased adjustable range to 700-1000°. Dimensions: 7¼" x 2¾" x 2¼". Vapor tight base and cover with gasket available at slight extra charge.

INSTRUMENTS ALSO BUILT TO SPECIFICATIONS

Making Precision Controls for over 10 years

BURLING INSTRUMENT CO.
251C Springfield Ave.
Newark, N. J.

which entirely surrounds dial face. This permits using standard metal dial. Pointers cannot stick or readings be distorted. New illuminated instruments are available in 2" and 3" sizes, in both rectangular and round cases.—*Simpson Electric Co., 5216 Kinzie St., Chicago 44, Ill.*

Please mention number 535 when filling out card

All-purpose Draft Gage

New "Model MZF" all-purpose draft gage is supplied with 9 feet of rubber tubing and a 5" metal sampling tube,

can be used at point of measurement, or at a distance; can be quickly mounted on a panel, hung on a wall or simply set on any flat surface. An exceptionally large area diaphragm is enclosed in a metal housing. Distinctive 3"-wide scale can be read in dim light; zero adjustment can be made without removing any parts. Dimensions 4¾" × 7½" × 3" deep. Illustrated is 0.25" gage in production; other ranges will follow.—*Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh 8, Penna.*

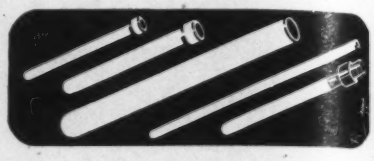
Please mention number 536 when filling out card

Periscopic Aircraft Sextant

New periscopic sextant is designed to increase safety for crews and passengers by permitting structural changes that will eliminate the plastic astrodome. It will remove danger to passengers caused by explosive decompression; increase speed of airplane by eliminating drag of astrodome; simplify taking astronomical sights for accurate navigation. A portion of periscope, a little more than 1" diam. × 1½" long is exposed through a special mount in skin of plane. Mount is sealed with a universal joint assembly. Sextant is removed from mount and stored within plane when not in use. Installation is

MONTGOMERY TUBES

for Thermocouple Protection or for Radiant Target Sighting

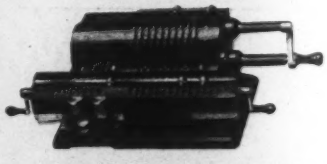


Montgomery high refractory tubes, porcelain, mullite and corundum, are widely used in applications above 2000°F. They are available in all popular and special sizes.

We also manufacture Crucibles for laboratory analysis. Tell us your requirements.

WHEATSTONE CORPORATION
Manufacturers of refractory porcelains
2436 READING RD., CINCINNATI 2, O.

SINCE 1874
ORIGINAL-ODHNER
"THE MACHINE TO COUNT ON"



A HANDY CALCULATOR

NEW BACK TRANSFER DEVICE SPEEDS UP CALCULATIONS

HERE'S THE ANSWER to the engineer's demand for a low priced, fast calculator. Entirely portable. Ready to go any place —any time. Hundreds of auxiliary uses in large organizations. Keep one on every desk, where quick calculations are necessary.

USE MORE MACHINES TO SERVE MORE PEOPLE AT LESS COST

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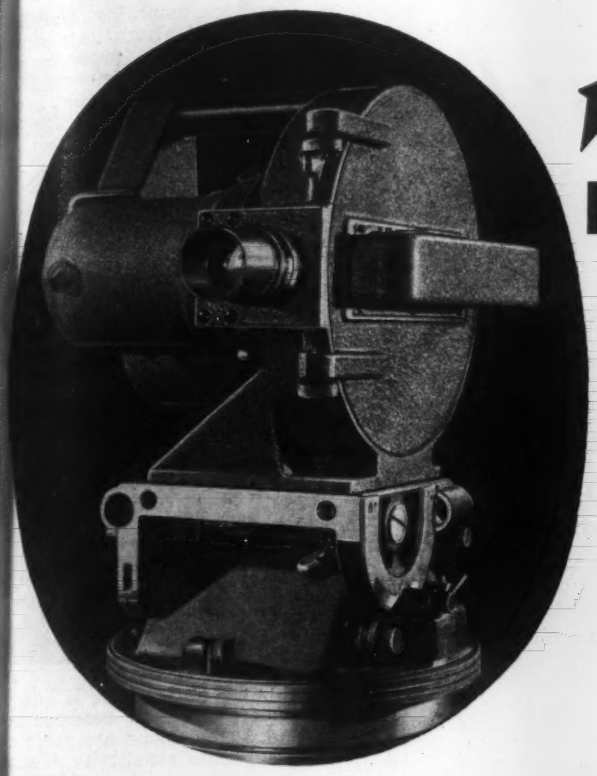
Ask for Bulletin ZO-53



Western Electric
FASTAX CAMERA

World's fastest portable motion picture camera aids in research, design engineering, and testing

The Western Electric Fastax Camera photographs in motion pictures all kinds of short-duration phenomena, reveals the secrets of rapidly moving parts, solves many industrial problems.

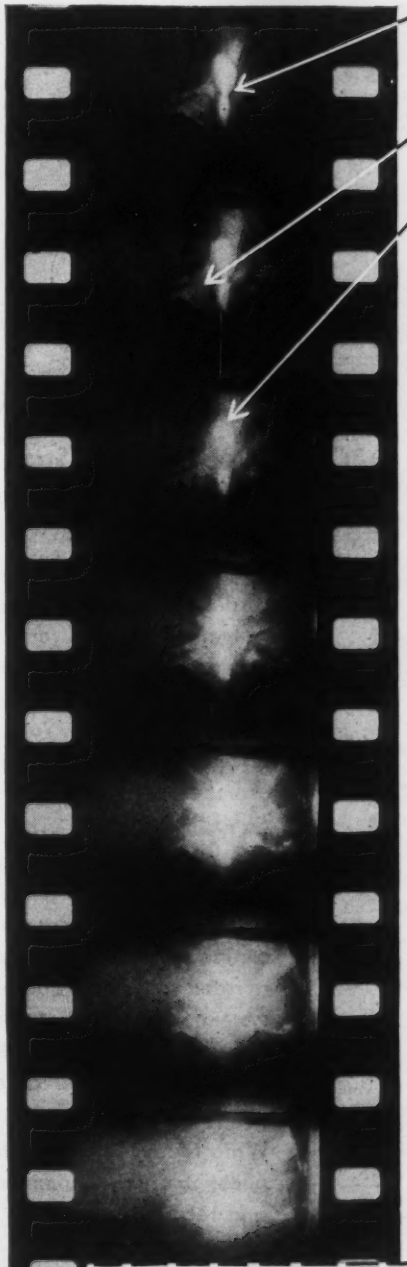
You now have a choice of three models, all designed by Bell Telephone Laboratories: 8mm—taking from 300 to 8,000 pictures per second; 16mm—150 to 4,000 pictures per second; 35mm half-frame—500 to 3,500 pictures per second. They have an improved and fully coated optical system . . . make pictures indoors or outdoors . . . in black-and-white or color.

When Fastax pictures are projected at the normal speed of 16 frames per second, a time "magnification" of from 10 to 500 times allows you to see exactly what has happened.

In research and design engineering of products having moving parts — as well as in testing materials and finished products—the Fastax Camera is an invaluable tool that shows up frailties and leads to better design.

For complete information, send the coupon—or call your local representative of the Graybar Electric Co.

— QUALITY COUNTS —



SEE how it works for the electric power industry

These unretouched Fastax pictures are taken from a study made by the I-T-E Circuit Breaker Company, Philadelphia, to show contact operation and the arc occurring when an I-T-E circuit breaker "makes" and "breaks" contact. Here you see the beginning of the "break" in a circuit carrying 12,000 amperes at 350 volts. The time covered by these seven frames is only *1.7 thousandths* of a second.

Pictures were made on 16mm film at a speed of 4,000 frames per second.

The Fastax Camera is ideal for studying many types of phenomena as well as the functioning of motors, generators, governors, fans, communications equipment and other electrical products.

SEND THIS COUPON TODAY

Graybar Electric Company, Dept. I-23
420 Lexington Ave., New York 17, N. Y.

Please send me bulletin T-2314 giving full information about Western Electric Fastax Cameras.

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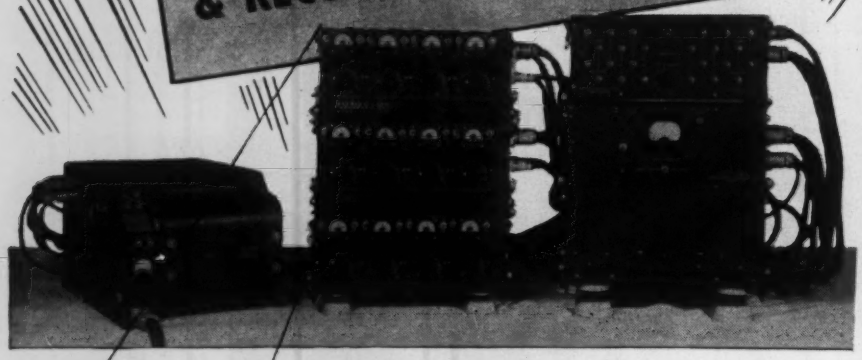
Something New!..

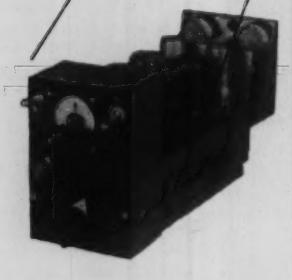
IN

ELECTRONIC MEASURING & RECORDING EQUIPMENT



Consolidated Unitized Static-Dynamic

10-kc. Carrier System "C"



This new development in measuring and recording equipment offers a light, compact system having high-frequency response, maximum sensitivity and stability. The accuracy of recorded static or dynamic information through a frequency range of 0 to 1,000 cps. is well within limits required by research laboratories and engineering development organizations.

The component Bridge-Amplifier Units plug into a rack-type case designed to hold four channels. The Oscillator and Power Supply, contained in separate cases, furnish current at rated voltages to operate a twelve-channel system. Four, eight or twelve channels may be employed as desired. All equipment is designed to withstand accelerations normally encountered in aircraft flight testing.

Write today for information concerning application of this equipment to your measuring and recording problems.

COMPONENTS

Bridge Amplifiers
—Type 1-114. Unitized self-contained assembly —Weight—3.5 pounds.

10-kc. Oscillator
—Type 2-106. Inherently stable phase-shift oscillator.

Power Supply
—Type 3-114 (12-volt D.C.) or Type 3-116 (115 volt,-50-400-cycle A.C.).

Recording Oscillographs
—Type 5-101B 14-trace.
—Type 5-114 18-trace.
—Type 5-115 36-trace.

Consolidated Engineering Corporation

Designers and Manufacturers of Analytical Measurement Equipment

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designed for shock mounting. Seal between assembly and aircraft structure withstands differential pressure of 15 lbs./in.².—*Kollsman Instrument Div. of Square D Co., 8008 45th Ave., Elmhurst, L. I., N. Y.*

Please mention number 537 when filling out card

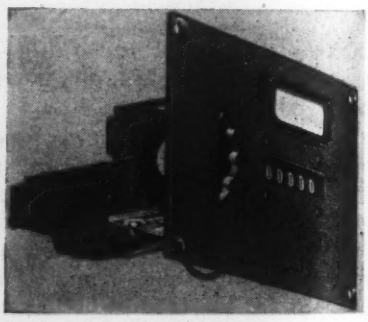
Pocket-size Ohmmeter

New inexpensive prod-type pocket-sized ohmmeter for spot-checking circuit components, relays, etc., is enclosed in tubular plastic case ⅞" diam. and 5¾" overall. Direct readings between 0 and 10,000 ohms are given on a 1.5-ma. full-scale sensitivity Weston indicator in series with a 1000-ohm molded carbon resistor and a standard penlight dry cell. Test electrodes include a built-in stainless steel prod and one secured to tip of a 17" test cord.—*Radio Tube Div., Sylvania Electric Products Inc., 500 Fifth Avenue, New York 18, N. Y.*

Please mention number 538 when filling out card

Electric Counters for Panel Mounting

New "Wizard Panelmount" electrically-operated counters are designed for installation, reading and reset from front of panel. Any number can be grouped on a centralized count control panel; or on a panel with other flush-mounted instruments, or on individual machines. They are made in 4- and 6-digit models with front-of-panel knob reset or key reset, in any required voltage up to 220 a.c. or d.c.—*Production Instrument Co., 702 W. Jackson Blvd., Chicago 6, Ill.*



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Fiber Extensometer

New "Sookne-Harris Fiber Extensometer" for studying load-elongation

PERMANENT MAGNETS MAY DO IT BETTER

Here Permanent Magnets are Designed

···FOR RESULTS!

The Indiana Steel Products Company offers you the advantages of the largest facilities in the world for the manufacture of permanent magnets and complete permanent magnet sub-assemblies.

Results that pay off in performance are the results you get in permanent magnets made by *The Indiana Steel Products Company.* Here permanent magnets are functionally designed and manufactured to meet exacting specifications for *more efficient and economical* performance of the device or instrument they serve.

This Is No Secret Formula...

The chart shows the typical demagnetization and energy product curves on which our engineers base their calculations. It shows the characteristics of various kinds of permanent magnet materials which can be expected in our production, and from which the optimum designs can be determined. Such fundamental information permits us to engineer the inside of your magnet so that each one will give you a maximum result.

ALNICO (Cast and Sintered) • CUNICO • CUNIFE • VECTOLITE • SILMANAL

Watch for Indalloy

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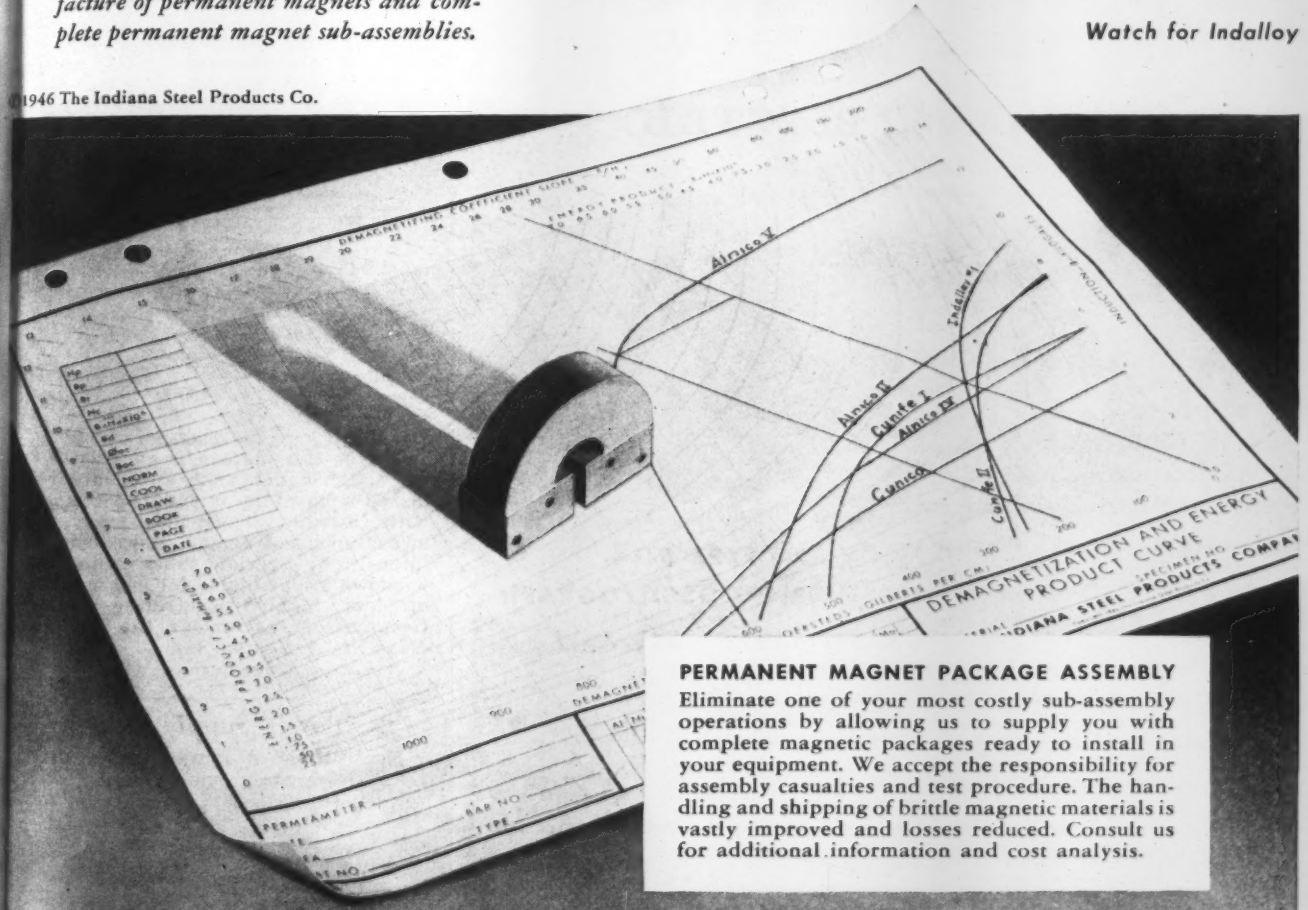

PERMANENT MAGNET PACKAGE ASSEMBLY

Eliminate one of your most costly sub-assembly operations by allowing us to supply you with complete magnetic packages ready to install in your equipment. We accept the responsibility for assembly casualties and test procedure. The handling and shipping of brittle magnetic materials is vastly improved and losses reduced. Consult us for additional information and cost analysis.

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PRODUCERS OF "PACKAGED ENERGY"

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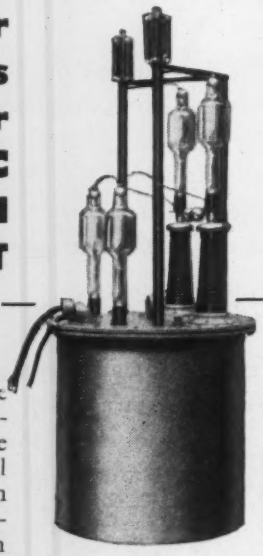
PLANTS { VALPARAISO, INDIANA / STAMFORD, CONN.

power supplies for ELECTRIC PRECIPITATION EQUIPMENT



Manufacturers of high-voltage precipitation equipment are invited to take advantage of the extensive experience General Electric has had in the design and application of precipitation transformers for use with electronic or mechanical rectifiers—and with the necessary control for this equipment. Simply send us your voltage and capacity specifications together with any special requirements as to wave shape, need for full or half wave, or for smoothness of output. Our engineers will offer the design best suited to your application. Address inquiries to our nearest office or to *Apparatus Department, General Electric Company, Schenectady 5, N.Y.*

GENERAL ELECTRIC

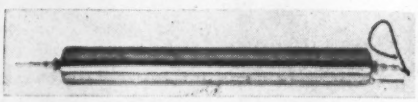
401-77

properties of single fibers utilizes principle of an automatic Chainomatic balance, produces an ink-drawn record of load-elongation characteristics of almost any textile fiber. Recording is accomplished by a capillary-flow pen on ordinary graph paper. Several ranges of loads and rates of extension are provided. In addition to the load-elongation curve to the break, one or more hysteresis cycles can be readily obtained to permit study of a fiber's ability to recover from extension. Instrument records in a form suitable for evaluation of fundamental parameters obtainable from load-elongation curves, such as Young's Modulus, work required to elongate to a given extension temporary set, etc. Relaxation curves, in which rate of decay of tension at a constant elongation is studied, are likewise within scope of instrument. With slight modification, apparatus is also capable of providing sensitive measurements of folding properties, especially flexibility and resilience, of lightweight fabrics, or compressional properties of pile fabrics at extremely low pressures.—*Harris Instruments, Inc., 1246 Taylor Street, N.W., Washington 11, D. C.*

Please mention number 540 when filling out card

Geiger-Muller Counter Tubes

New all-metal Geiger-Muller Counter Tube is said to offer many advantages by new construction, among them: (1) Mechanical robustness; (2) Active diameter of counter nearly equal to outside diameter and active volume



maximal for tube size; (3) Low intrinsic background count. A wide variety of sizes is offered ranging from ½" diameter and ½" long to 3" diameter and 5 feet long. Operating voltage is about 1000 volts; cosmic ray efficiency is better than 99%; plateau (range of operating voltage) is 100 volts or more and change in counting rate over this plateau is guaranteed to be $< 0.05\%$ per volt. Tubes are furnished separately or supplied complete with auxiliary systems, ready for measurement of gamma and cosmic ray intensities. Special tubes with thin windows are available for measurement of less highly penetrating rays.—*Geophysical Instrument Co., 1820 N. Nash St., Arlington, Va.*

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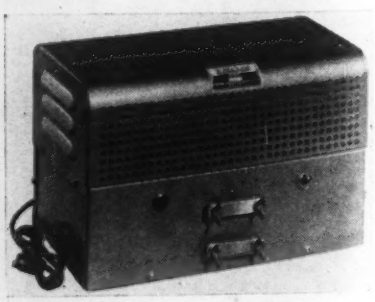
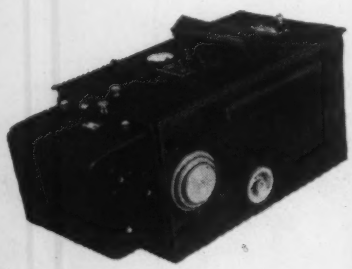
Power Supply Unit

New "Model A Power Supply Unit" is claimed to provide "much better voltage regulation than has heretofore

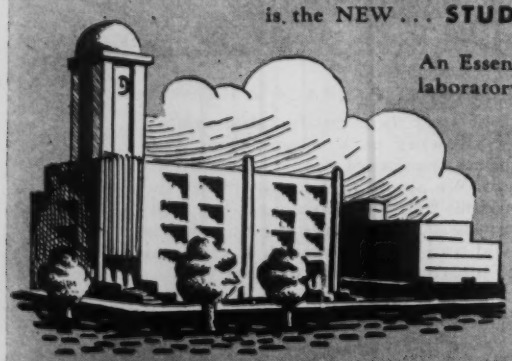


TODAY'S SCHOOLS...

must train for TOMORROW — a challenge intensified by the accelerating pace of scientific and engineering advance.



Specially designed to meet the needs of modern education, is the NEW . . . **TYPE S-14 STUDENT'S OSCILLOGRAPH**



An Essential part of the modern college laboratory:

- Accuracy, for the critical researcher
- Simplicity, for the undergraduate student
- 6 to 12 channels, precision components

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Hathaway INSTRUMENT COMPANY
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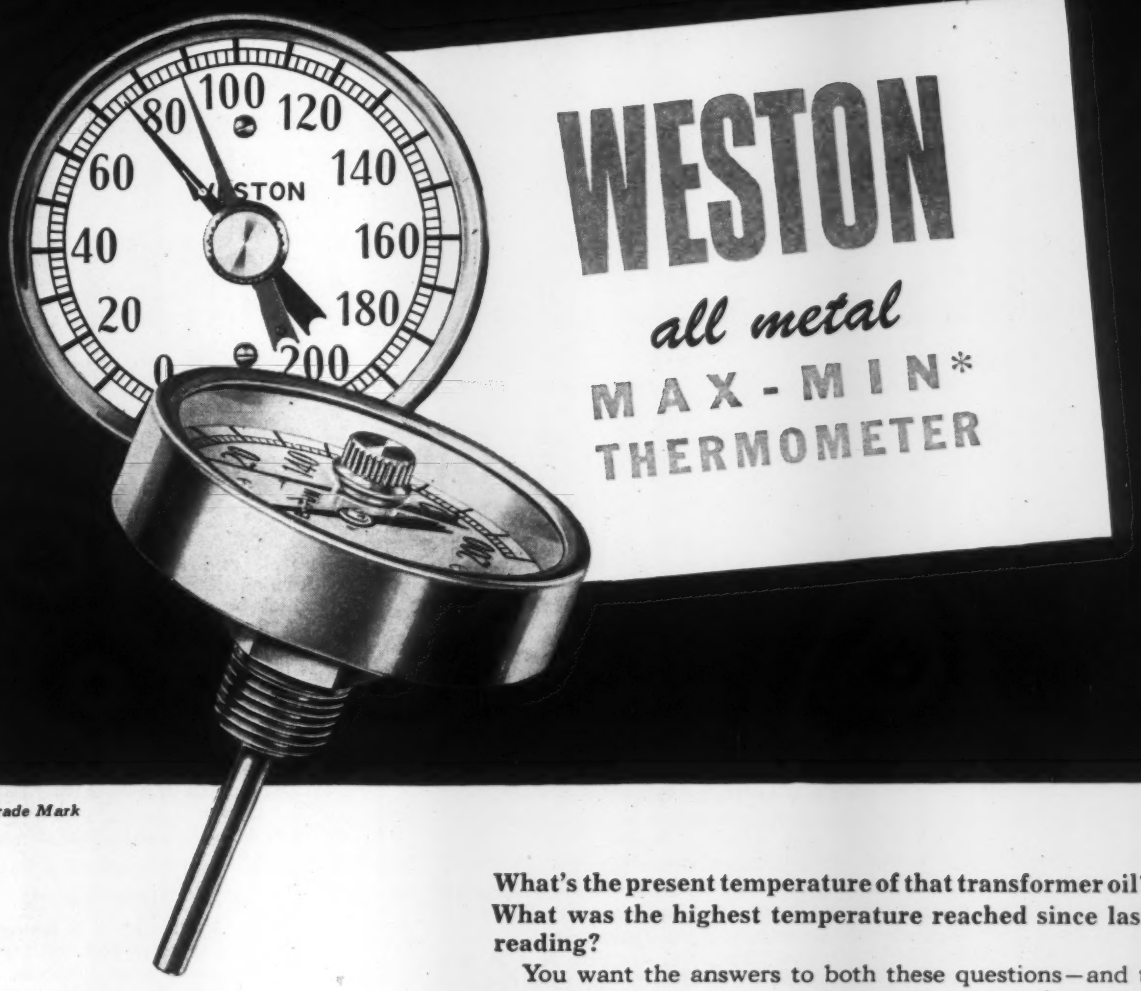
THE THERMOMETER THAT *REMEMBERS!*



*Registered Trade Mark

What's the present temperature of that transformer oil? What was the highest temperature reached since last reading?

You want the answers to both these questions—and the MAX-MIN gives them... accurately!

The red index pointer on the MAX-MIN is manually set to either the low or high side of the main indicating pointer. When set on the high side, for example, it moves as the temperature increases, always remaining at the extreme temperature reached, until manually re-set. Thus in one quick reading you get both *present* temperature and the *peak* temperature since last reading.

For complete details see your jobber or local Weston representative. Weston Electrical Instrument Corporation, 591 Frelinghuysen Avenue, Newark 5, New Jersey.

WESTON *Instruments*

ALBANY · ATLANTA · BOSTON · BUFFALO · CHARLOTTE · CHICAGO · CINCINNATI · CLEVELAND · DALLAS · DENVER · DETROIT · JACKSONVILLE · KNOXVILLE · LITTLE ROCK · LOS ANGELES · MERIDEN · MINNEAPOLIS · NEWARK
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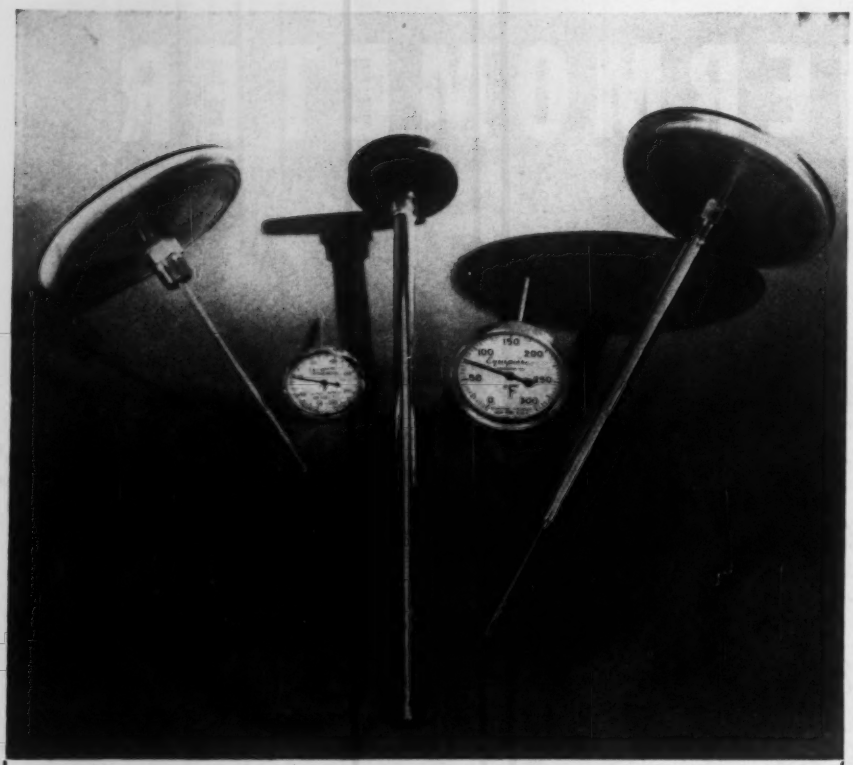

Equipoise PRECISION

Bimetallic Dial Thermometers

for every industrial and laboratory use

Widely used in power plants, chemical plants, oil refineries, paper and textile mills, etc. Also on refrigeration, air conditioning and electrical equipment.

Many standard ranges are available between the limits of minus 90°F. and 1000°F.

- Easy to Read Dial
- Quick Response
- Only One Moving Part
- High Over-range Protection
- Individually and Permanently Calibrated
- No Pinions, Gears or Linkages
- Calibration Unaffected by Vibration
- Durable Stainless Case, Connection Nut & Stem
- Available with Tempered, Non-breakable Crystals
- Available in 2, 3 & 6 inch Dial Sizes
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- Low Cost—No Maintenance

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Kansas City, Mo.—Control Equipment Co.
St. Louis, Mo.—MacGregor-Sears Co.
Chicago, Ill.—Nielsen & Fryer, Inc.
Detroit—D. T. Randall & Co.
Boston, Mass.—R. T. Forbes Co.
Albany, N. Y.—Carl J. Schultz
Atlanta, Ga.—Thermal Engineering Co.
Jacksonville, Florida—Richard Barthelmess Sales Co.

been possible in conventional type power supply units." It can be used for any purpose where a 6- or 12-volt source of power is required. Unit is described as consisting of two 6-volt 7.5- ampere filtered d-c. power sources which can be placed in parallel for 15-ampere continuous service or in series for 12-volt 7.5-ampere continuous service. Weight 31 lbs.; dimensions 7¾" × 7¾" × 11¾" long.—*Electro Products Laboratories, Inc., 549 W. Randolph St., Chicago 6, Illinois.*

Please mention number 542 when filling out card

Electrical Appliance Tester

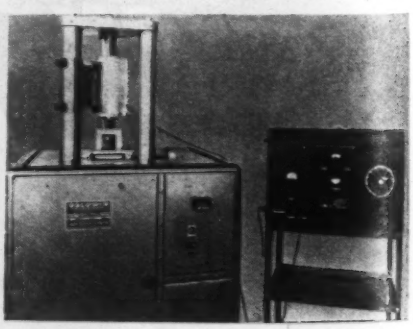
New "Model 390" electrical appliance tester, described as "no larger than a man's hand, no heavier than an average

novel, and rugged as a bull-pup," is furnished with a "Break-In" plug which has four color-coded leads. Leads are first attached to instrument, then plug placed in an outlet and appliance is plugged into it. Voltage readings will register immediately. Then, to get wattage or ampere readings, depress one of two buttons at bottom of panel. Ranges: a-c., volts: 0-150, 0-300; amperes: 0-3, 0-15; watts: 0-300, 0-600, 0-1500, 0-3000.—*Simpson Electric Co., 5216 Kinzie St., Chicago 44, Ill.*

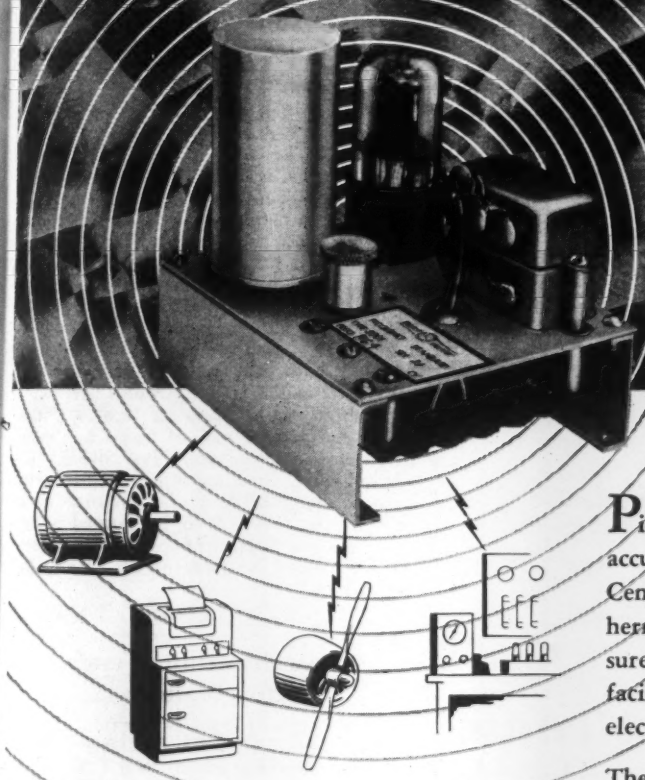
Please mention number 543 when filling out card

Fatigue Tester

New "Model SF-4 Sonntag Fatigue Machine" is equipped for tension-compression testing at ambient and high temperatures. It embodies principles of Sonntag Universal Fatigue Machines, particularly automatic maintenance of constant load. Maximum capacity in either direction is 10,000 lbs. Static preload capacity, 0 to 5,000 lbs.; alternating (dynamic) load capacity, ± 5,000



PICK A NUMBER



Pictured here is a tuning-fork frequency standard with accuracy guaranteed to one part per million per degree Centigrade. The fork is temperature-compensated and hermetically sealed against variations of barometric pressure. This standard, when combined with basic equipment, facilitates accurate speed and time control by mechanical, electrical, acoustical or optical means.

The unit is available separately or in conjunction with complete timing instruments. Our engineers are ready to cooperate on any problem.

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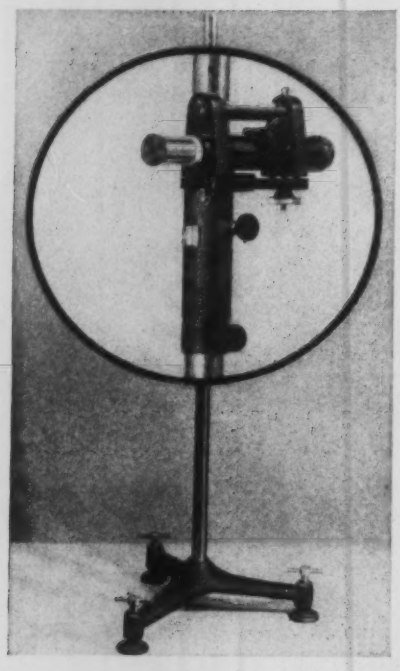
American Time Products Inc.

580 Fifth Avenue

Gaertner

M909-M910 CATHETOMETERS



For vertical measurements requiring an inexpensive yet reasonably accurate instrument. Lightweight and portable.

RANGE OF MEASUREMENT

M909: 50 cm.
M910: 100 cm.

SCALE

Precision scale divided into millimeters with each centimeter numbered. Vernier reads to 0.1 mm.

GUIDE ROD

Of nickel-plated selected steel. 30 mm in diameter.

BASE

Cast iron. Tripod design. Furnished with leveling screws and foot plates.

TELESCOPE

Range of working distance: 60 cm to infinity. (A microscope can be supplied for shorter working distances.)

Magnification: at infinity 8.5X, at 60 cm 17.5X.

Rack and pinion focusing.

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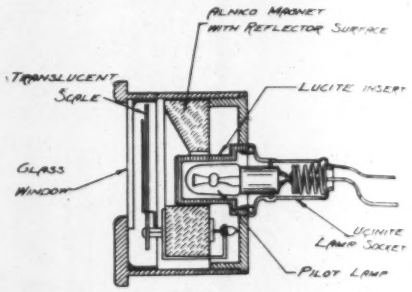
Please mention number 544 when filling out card

Illuminated-dial Electrical Instruments

New dial-illuminated panel-type instruments are free from two drawbacks of former design: (1) aperture in back



where bulbs were inserted and where thermal currents sucked in dust and other foreign matter, (2) frequent use of oversized replacement bulbs which were forced into opening and damaged mechanism. New design, applicable to all 2½" and 3½" Marion round and square instruments, 4½" rectangular instrument and "Model 52S Tuning Meter" (but not to Marion "Hermetics"), utilizes a transparent Lucite cavity which seals opening against dust, while controlling size of bulbs and safeguarding mechanism. New design assures even illumination across dial with a new specially-developed Alnico magnet whose front face is shaped somewhat like a flashlight reflector.—*Marion Electrical Instrument Co., Manchester, N. H.*

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Heat-distortion Tester for Plastics

New "Aminco Heat Distortion Tester" for determining heat distortion of plastics according to A.S.T.M. D648 comprises an oil bath heated by a 2000-watt immersion heater, a centrifugal pump for circulating bath liquid, a coil for cooling bath liquid to room temperature after each test, a synchronous-motor-driven bimetallic thermoregulator, a control box, four specimen holders, and a loading stand for specimen holders. Thermoregulator automatically maintains a 2°C. per minute rate of temperature rise throughout range from ambient to 150°C. Weights permit total loads of 625, 1,250 and 2,500 grams to be imposed on loading rod of each specimen holder. — *American Instrument Co., Silver Spring, Md.*

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Piston-cam Contour Gage

New "Electrolimit Contour Gage" is a two-station gaging fixture designed

Arnold presents:

another step towards a complete line of permanent magnet materials . . . . .

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SINTERED ALNICO

In general SINTERED ALNICO MAGNETS do not compete with, but rather supplement, magnets produced by the cast method to widen the scope of potential permanent magnet applications.

Alnico magnets weighing roughly one ounce or less should be produced by the sintered method.

Heavier magnets of more intricate shapes can be produced. For some applications Sintered magnets are more economical because:

1. Magnetic characteristics are practically the same as Cast Alnico.
2. Sintered Alnico is a fine-grain, homogeneous material which has more uniform flux density, is easier to grind, and provides better surface finish.
3. Sintered Alnico magnets can be produced to closer dimensional tolerances:

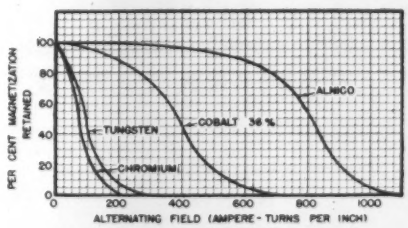
SINTERED ALNICO II	CAST ALNICO II
0.000 to 0.125 — + .005	0.000 to 2.00 — ± 1/64
0.126 to 0.625 — + .010	2.0 to 4.0 — ± 1/32
0.626 to 1.250 — + .015	4.0 to 6.0 — ± 3/64
1.251 to 3.000 — + .062	

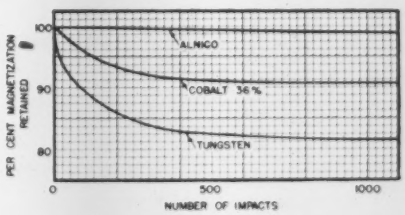
Grinding can in many applications be eliminated.

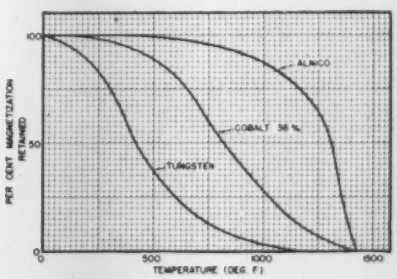
4. More intricate shapes, including holes, inserts, etc., are more feasible.
5. Transverse modulus of rupture is several times greater.

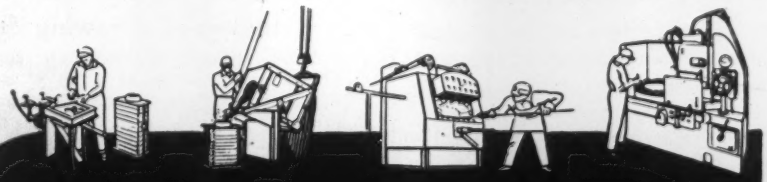
All Alnico, and particularly Sintered magnets, have very high values of Coercive Force (which is the capability of resisting demagnetization or loss of magnetism due to stray fields and from heat and vibration).

The curves show roughly the effect of these demagnetization factors on Alnico compared to other alloy steels.









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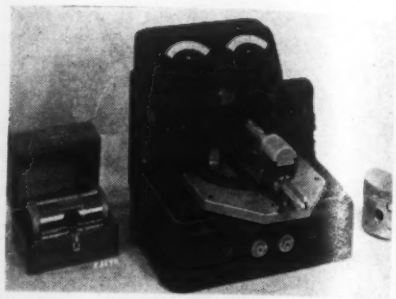

for checking cam contour of centerless cam ground pistons. It consists of a floating pressure shoe arbor mounted on a slide so that arbor may be pulled out to install piston for gaging and to remove piston after it is measured. Arbor assembly rotates through 180°. Two "Electrolimit" heads indicate cam contour. Each head has a floating gaging point and a fixed pickup point.—*Pratt & Whitney Div., Niles-Bement-Pond Co., West Hartford, Conn.*

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New "Ederscope" is a 25× pocket microscope (size and weight of a fountain pen) for professional as well

as student use. It bridges gap between low-power magnifiers and expensive bench microscopes. Optical system is said to comprise finest precision ground and polished lenses. Definition is sharp and there is no distortion over full field. No support is required. Barrel and focusing extension are made of stainless steel.—*Schneider-Cogswell, Inc., 1849-I North Halsted St., Chicago 14, Illinois.*

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Industrial Drawing Set

New industrial drawing set comprises beam compass with 8″ and 13″ beams, 6″ giant bow compass, ruling pen with club style wood handle and draftsman's refillable pencil that can be converted into a double-point pencil. New feature of ruling pen is calibrated adjusting collet that enables user to regulate opening of nibs and at the same time record desired setting for future use: desired width of line can easily be duplicated. New giant bow compass feature: lead of pencil part can easily be advanced, by slightly turning adjusting collar, to desired

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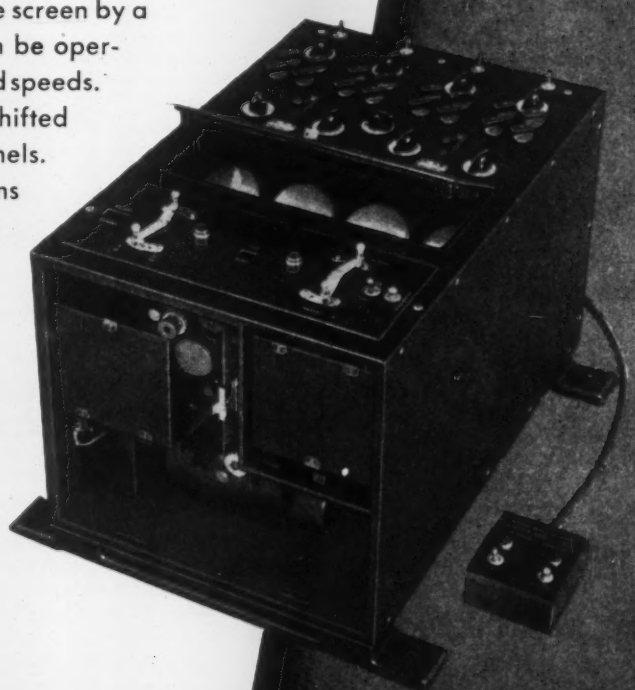

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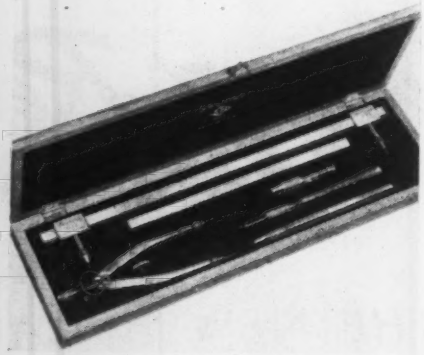

length for easy sharpening without soiling fingers or smudging tracings. Compass draws circles from 1/16" to 8" in diameter. — *Charles Bruning Co., 4754-18 Montrose Avenue, Chicago 41, Illinois.*

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Torque Screw Driver

The New "Model CSD-15 Trutorq Screw Driver" operates on friction-disk principle, with accuracy said to be within a fraction of an inch-pound after as many as 300,000 continuous operations. Calibrated head allows operator to set it at any desired torque (from 1 to 15 inch-pounds), without the use of other calibrating devices. Maximum diameter of handle is ⅞"; weight 3½ oz.; length complete with blade is 6¼". No springs, no pointers, and no dials to read. Special design of handle is said to provide maximum comfort and facility in operation. Various blades and bits available. — *Airdraulics Engineering, Inc., New Canaan, Conn.*

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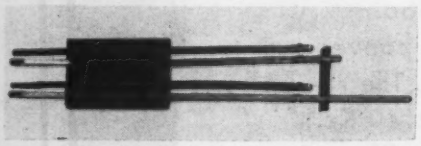
Standard Contact-spring Assemblies

New specification sheet on contact-spring assemblies contains detailed dimensional drawings of three groups



of standard contact springs, permitting a selection for conventional spring stack-up in a wide range of circuit possibilities, and enabling engineers to specify standard tooled parts.—*P. R. Mallory & Co., Inc., Indianapolis 6, Ind.*

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Fog-preventive Glass Cleaner

New "C-All" is a glass cleaning anti-fogging agent for use on instrument covers, eye glasses, and any other glass surfaces subject to fog formation. It is a water white liquid applied with a cloth and wiping until clean. "C-All" cleans glass surface and deposits an invisible film that "prevents fog formation for a relatively long time."—*Engineering Associates, Inc., St. Charles, Illinois.*

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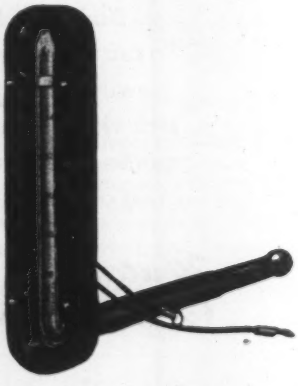

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GUEST EDITORIAL

Measurement—Tool of Science and Industry*

By **HUGH L. DRYDEN, Associate Director, National Bureau of Standards**

IT is a pleasure to bring to the Instrument Society of America the greetings of Dr. Condon and the staff of the National Bureau of Standards. The primary function of the Bureau is to provide fundamental standards of measurement and to investigate problems connected with their application in science and industry. Other functions are the conduct of numerous measurements in connection with the day-to-day business of the Federal government and the conduct of scientific research in the fields of physics, chemistry, and engineering. Your function is to devise, produce and use instruments by means of which standards are widely disseminated and innumerable physical magnitudes and properties of materials are measured. We thus have a community of interest in the broad subject of measurement.

The rapid growth of your own society is evidence of the universal and indispensable rôle of measurement in our modern world. To act intelligently requires knowledge and knowledge is often attainable by measurement. As Lord Kelvin so clearly stated many years ago:

> When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind.

Your field and ours is to find methods of expressing desirable and undesirable attributes and states in numbers, to promote agreement on these methods, and to provide the instruments for accurate measurement.

I propose tonight to consider with you our common responsibility, the purposes to be served in science and industry by measurement, and some of the more recent trends in the development of instrumentation. Some of these trends I will illustrate from recent work at the Bureau.

Our Common Responsibility

I am constantly amazed by the general public's confidence in the readings of any instrument having a good appearance. The automobile driver swears by his speedometer; doesn't the needle point to 30 miles per hour? The housewife looks at the thermometer to see whether she ought to feel too warm or too cold. Even engineers who should be more skeptical have contracted the habit of relying on instrument readings. This naïve faith has in general been justified by the care which the instrument industry has exercised in the control of the accuracy of its products. Nevertheless this great faith in the readings of instruments should continually remind us of the responsibility resting upon us to justify that faith. We have an obligation to promote the correct use of instruments in a manner to secure uniformity and mutual understanding.

Why Measure?

The oldest function of measurement in society appears to have been in the control of the quantity of commodities when sold or exchanged. Such methods were devised many centuries before the Christian era and many of them are referred to in the Bible. As time went on, the quality of commodities became of an importance at least equal to that of the quantity. Every commodity is measured many times and for many characteristics before it reaches the ultimate consumer. Through such measurements the manufacturer maintains the quality of his product, assures its fitness for the intended use, and points the way to its continued improvement. Through measurements the manufacturer, the buyer and the user speak a common language in describing the product, thus promoting fair dealing in daily trade all over the world.

This function of measurement touches the daily life of every citizen.

A second function of measurement is the control of the safe and efficient operation of mechanical and electrical machines and devices. The mastery of heat and power and its control in the service of mankind is the foundation of our industrial civilization. This mastery and control rests on measurement of the pressure, temperature and rate of flow of the steam, the electrical voltage, current and power at the switchboard, the speed of rotating machinery, the stress at critical points in machines, and thousands of similar measurements. The cockpit of a modern aircraft has scores of instruments for measuring the many factors which must be known to assure safety and efficiency. Every automobile has at least the five instruments needed to measure one element of performance of each of the five essential systems, i.e. the fuel supply, the oil pressure, the cooling water temperature, the electric current to or from the battery, and the speed.

This rôle of instrumentation is well-known in the plants producing the many materials and products appearing in trade and commerce. Temperature-measuring devices assure the proper conditions for making satisfactory steel, for cracking petroleum to obtain a desired grade of gasoline, and even for baking bread. Nearly every modern industry has passed from the stage of operations on the basis of the knowledge and experience of skilled craftsmen to the use of accurate instrumentation for measuring and controlling the manufacturing process.

A third function of measurement is to serve as a research tool in the advancement of basic scientific knowledge. I have already referred to Lord Kelvin's appraisal of measurement as a factor in scientific knowledge. Science depends on the recognition and quantitative measurement of identifiable aspects of the physical world. The electrical industry exists because science has learned to isolate and accurately measure various aspects of electrical phenomena. There is an extremely close interrelation of the progress of any branch of science and the status of the art of measurement in that branch. Thus knowledge advances the art of measurement, but likewise advances in the art of measurement accelerate the increase of scientific knowledge. In general, scientific research men are seeking to secure by measurement more basic information or more accurate information, whereas in industry the measurement is a tool to be used in controlling quality. Nevertheless there have been repeated instances of an instrument devised originally purely for scientific purposes finding extensive application in industry, e.g. the optical, infrared and mass spectrometers. Similarly, the wide availability of improved instruments in industry, e.g. the cathode-ray oscillograph, has tremendously accelerated advances in many fields of science.

*Presented at the Spring Meeting of the Instrument Society of America, Cleveland, April 24, 1947.

OUR Guest Editor frequently flies from coast to coast and over the seas; he heads up important activities of numerous scientific and technical societies (Past-President of the Institute of the Aeronautical Sciences, for example). Therefore, hundreds of our readers have seen him and will support our assertion that this picture does not do him justice. The best commercial photographers in Washington had shot a good likeness of Dr. Dryden and we had entrusted it to the best photoengravers in Pittsburgh. Then what happened? Those little dots arranged themselves with malice aforethought to turn his twinkle into a squint and his smile into a frown! In short, the lenses, screens, etchants, etc., conspired to commit the sin of INaccuracy against a famous Priest of Precision who has tended the Temple of Truth (the NBS) since he was twenty years old! Yes, Dryden was born in 1898 in Maryland, received his B.A. at Johns Hopkins in 1916, A.M. in 1918 and Ph.D. in physics and mathematics in 1919. Just before his twentieth birthday in 1918, he was signed up by the NBS. He was made chief of the Aerodynamics Section when he was twenty-two. An adequate record of his pre-war achievements (supersonic-speed airfoils, etc.) would fill this page, so we'll skip to his war-time service as chief of Section 5.1 of the Division of New Missiles of the NDRC where he guided the development of the "Bat" (radar homing missile), receiving for this job the Presidential Certificate of Merit. He worked on numerous committees dealing with guided missiles under the Joint Chiefs of Staff, NACA, Army Ordnance and AAF. His work on the AAF Scientific Advisory Group appointed by General Arnold won him the Medal of Freedom. He is chairman of the Guided Missiles and Pilotless Aircraft Panel of the AAF Scientific Advisory Board and a member of the Guided Missiles Committee of the Joint Research and Development Board . . . and . . . and . . . one heluva good guy!

Underwood & Underwood

—M. F. BEHAR, *Editor*

A fourth function of measurement is the extension of the human senses. While this function is not wholly distinct from the three previously mentioned, this function deserves separate recognition and does cover some applications of instrumentation not related to the other three. Science has long since passed beyond those aspects of physical phenomena perceived by the senses of man. Electricity is perceived only through its physical effects, and all of the knowledge we possess about electricity has been obtained by accurate measurement of these effects. So precise are these measurements that we talk confidently of accuracies of a part in a million.

The war has brought to the public a greater knowledge of recent extension of our sensory powers by physical measurements. Radar, which enables us to see through clouds and darkness at distances up to a few hundred miles, is well-known, although the layman may at first be disappointed in the limited amount of detail available. The use of infrared radiation to permit a more satisfactory vision at moderate distances at night is one of the interesting war-time applications of measurement to a phenomenon not ordinarily perceived by the senses. In the atomic age we are confronted with new phenomena dangerous to human life of which our human senses receive no warning. An instrument, the Geiger counter, fills the gap: it detects these dangerous radiations.

These extensions of our senses by means of instruments were by no means confined to war-time developments. They have been in progress from remote antiquity—from the time of the first device for celestial navigation, through the development of the magnetic compass and of the telescope, down to the present time. The applications to geophysical prospecting for oil and minerals, of precise measurements of the earth's gravitational attraction on a suspended mass, of electric and magnetic anomalies and of times of travel of pressure waves are excellent illustrations of this function of extending the human senses.

What Next?

We are often asked at the National Bureau of Standards when our work on standards of measurement and the problems arising in connection with their application in science and industry will be "completed." Can we not establish the standards of length, mass, time, etc., once for all?

From the remarks already made as to the rôle of measurement in our present-day world, it is obvious that your work and our work will *never* be completed as long as science and technology continue to grow—and there is no reason to expect their growth to cease; on the contrary we are on the threshold of a new age, the age of nuclear energy, and we are in the midst of a period of intensive application of scientific knowledge to industrial processes. Prudent foresight dictates that your activities and ours should be expanded, not contracted.

Some of the trends of development of the field of measurement, as I see them, are the growth in the number of things to be measured and their complexity, the need in industrial and scientific work of more accurate measurements, the remarkable increase in the application of electrical methods to all kinds of measurements, and the beneficial results from interchange and cross-fertilization among various fields of application of instrumentation.

Some few years ago I happened to notice on the floor of our shipping and receiving room at the Bureau an incoming shipment labeled "one quart human breath." This was so unusual a commodity that I inquired about it. It was indeed a sample submitted for test and correctly identified: the breath of a worker in one of the plants of the Manhattan Project to be examined for content of radioactive material. On the same day there were samples of synthetic rubber, of new plastic materials, adhesives, new anti-knock fuels and other materials not in existence a few years before.

There has been a tremendous growth in the number of things on which measurements are to be made, in the number of properties to be measured and in the complexity of the required measurements. Applications of atomic energy will require knowledge of the neutron absorption of materials, a new property to be measured. Since this property may be controlling, materials showing desirable characteristics in this respect will have to have other properties measured, such as their structural strength and rigidity at normal and high temperatures. The number of magnitudes that will need to be measured is ever increasing.

The measurements required are becoming more and more complex in character. Complex equipment has been developed to save man physical and mental labor, which can be operated properly only when its performance and condition are known. Measuring devices must be provided to translate the physical conditions to indications or records which are readily interpreted by the operator. Complexity has led to the development of remote indication so that the measurements of the performance of a whole power plant—or even of a whole electric power network—can be transferred to a single board where one individual can supervise the over-all performance. It is but a step to introduce automatic control of the operation of the plant, to use the pseudo-sensory reactions of the measuring instruments to command control mechanisms until the desired result is obtained to the satisfaction of the measuring instrument.

The trend in our common field of activity is thus to develop robots of great physical power, fully equipped with a highly precise and interlocked nervous system capable of all the activities of the reflex nervous system of man, often of higher precision, and in addition capable of primitive forms of judgment. You are the creators or expert users of these complex systems.

A second noticeable trend is the demand for increased accuraey of measurement in ordinary industrial applications of instruments. Those of us at the National Bureau of Standards are perhaps more keenly sensitive to this trend because it is our duty to try to keep one order of magnitude higher accuracy than that demanded in industry. We have seen the decimal point in industrial length measurements move to the left until accuracies of one ten-thousandth of an inch and one hundred-thousandth of an inch are fairly common. Anyone may purchase at moderate cost a timing device permitting the measurement of time intervals to an accuracy of one millionth of a second. In numerous other fields it is difficult to keep ahead of the demands of scientific and industrial users of the national standards of measurements. One of the reasons why we *do* keep ahead is that you spur us on in so many ways—one way being that you ship us your laboratory standards of mass, length, time, temperature, electrical magnitudes, etc., to be checked against our standards. You probably did not say "How amazing!" but "To be expected!" when you read that the Bureau made and supplied to the armed forces more than half a million pencil-size devices each capable of detecting less than one part of carbon monoxide in five hundred million parts of air.[1]

Through the whole gamut of instruments of all degrees of precision from the more qualitative to the most precise, you who are users are demanding more accuracy under more and more adverse conditions, because you find the higher accuracy economically advantageous. Precise knowledge means in general a more satisfactory product, and less waste of material and manpower.

A third trend is the increasing application of electrical and electronic methods to problems of measurement. The use of these methods permits the meeting of more rigorous requirements as regards sensitivity, accuracy and remote indication. Electrical methods are extremely flexible and adapted to the transfer and amplification of power. Other types of energy supplied by the detector of a physical magnitude are readily transformed to electric energy. As an example of this trend, it is estimated that the number of aircraft instruments using electrical transmission and indication of non-electrical magnitudes increased from less than 5 percent to more than 50 percent between 1935 and 1945.

Electronic instrumentation advanced rapidly during the war but we are just beginning to recognize the possibilities of peace-time applications. The accom-

(1) Anon. "New Indicator Detects 0.000,000,2 % CO." *Instruments*, Vol. 19, Dec. 1946. pages 722-733.

plishment of building a radio transmitter and receiver sufficiently small and sufficiently rugged to be used in a fuze on a shell fired from a gun[2] introduces a new concept of size and ruggedness as compared with that known before the war. My colleagues foresee electronic instruments and controls constituting readily-replaceable rugged units of small size adapted to large-scale mass production by machine methods. Components and techniques already developed include rugged subminiature electronic tubes, miniature capacitors made possible by the development of ceramic materials with high dielectric constant, and the printed electric circuit[3] suitable for mass production of a uniform product at low cost. Some of you may have seen the news report of a serviceable radio transmitter contained in a lipstick case built by the Bureau to demonstrate the application of these developments.

One must of course make a clear distinction between developments that can be completed in the near future and those which will come only after a period of further development. But, looking still farther ahead than the near future, my colleagues visualize applications of measurement and control by electrical and electronic means to the close control of many conditions in industrial processes, involving the continuous measurement of properties of the raw materials and end product, the automatized computation of the requisite adjustments to maintain the desired properties, and the automatic adjustment of the proportions of material and physical conditions to maintain the desired quality. This task is surely no more difficult than that of an automatically-tracking and -computing gunsight which measures the relative motion of a target, predicts its future position, computes the direction of the gun required to hit the target, and moves the gun to that position. The intensive development and use of high-speed electronic computing apparatus provides a background of experience for the further development of such instruments and their application to industrial problems.

In the specific field of sensory elements and transfer devices I should like to mention the wire strain gage. Because of its great importance and wide use, the National Bureau of Standards has made and is continuing to make a study of its accuracy, reliability, stability and general performance as affected by many variables. The principle has been known since Ohm's day but it required the idea of Simmons, Ruge and DeForest of bonding the wire to paper and the presence of modern methods for measuring and recording small changes in current before this principle blossomed out in hundreds of applications. In these applications the strain gage is used as a means of converting a mechanical change to a change in electric energy. By its small size and weight the device has made possible the accurate measurement of many magnitudes under rapidly-fluctuating conditions, in inaccessible locations and in places such as on the surface of rotating machinery. One of the most convenient and accurate devices I know for weighing large aircraft utilizes wire strain gages. This is of course a static application; the dynamic applications are of wide variety and ever-increasing importance.[4]

Another sensory element which I should like to mention is the vacuum-tube acceleration pick-up developed by Dr. Walter Ramberg of our staff. The pick-up resembles an ordinary radio tube but the plates are elastically mounted to deflect in response to acceleration normal to the plane of the plates. This deflection causes a change in plate current proportional to the acceleration. The device has a high output and high natural frequency, making it possible to record rapidly varying accelerations without an amplifier.[5]

The final trend in the development of the art of measurement to be discussed is the growing influence of the cross-fertilization of ideas among various fields. The establishment of scientific and technical journals devoted solely to instruments, the formation of professional divisions of the older technical societies and, particularly, the growth of the Instrument Society of America are the primary factors in this beneficial practice. It may be debatable whether there is such a thing as an art of measurement which can profitably develop apart from some field of science or technology, but there can be no reason to doubt the great benefits of the multiplicity of contacts and exchange of information among those whose primary concern is measurement. Familiarity with work in process in other fields frequently leads to new ideas.

I should like to describe one series of related developments at the National Bureau of Standards which illustrates this process at work. As you perhaps know the Bureau has some sixty specialized sections having contacts with many different industries and types of products; and fortunately there is fairly good interchange of information between them. The story relates to the use of diamonds for various types of measurements. One of the early interests of the Bureau in diamonds was as a tool for ruling lines on precision scales. In connection with this work C. G. Peters and F. Knoop devised apparatus and techniques for cutting diamonds to desired shapes with sharp straight edges free from nicks. When confronted with the problem of determining the hardness of glass and other brittle materials, Knoop and Peters devised an indentation method using a diamond indenting tool of elongated pyramidal form making a rhomb-shaped indentation of length about seven times the width.[6] The tool gives indentations of accurately-measurable length in the most resistant steels with loads of the order of one pound. The use of these light loads permits the extension of indentation tests to small specimens and to tests of brittle materials such as glass which shatter under the heavy loads required by most indentation-hardness testers. The Knoop indenter has been standardized as to dimensions and is the tool used in the Tukon Tester. It has been applied to determinations of the indentation hardness of glass, dental plastics, enamels, porcelains, electrodeposits, thin sheet metal, hardened surface layers on steel, and even to individual particles less than 0.001" in diameter in polished and etched surface of a specimen of steel. It has made possible measurements of the indentation hardness of tungsten, boron and silicon carbides.

While this development was in progress, H. C. Dickinson and S. A. McKee became acquainted with the indenting tool. They were engaged in studies of the wear of aircraft engine cylinders and were employing the standard gaging methods of measuring cylinder diameter at many places and obtaining the wear as the small difference of two large dimensions: the diameter before and after a certain period of operation. Dickinson and McKee recognized the possibility of measuring small amounts of wear by the change in length of a series of standard indentations of the general shape made by the Knoop indenter. The actual tool used in the Dickinson-McKee wear test apparatus is of somewhat different dimensions. It was soon found that the wear could be measured to a precision of 0.00002" and that smaller amounts could be detected. The wear occurring in a few hundred starts and stops was readily measurable, including the variation with depth below the top of the cylinder and circumferential position.

Further by-products of the work on diamonds were new methods of cutting diamonds and of drilling small diamond dies used in drawing and shaping extremely hard and fine wire, but these developments are outside the domain of our present subject.

This accelerated interchange of information should be encouraged in every possible manner and should be one of the primary objectives of the Instrument Society of America.

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(2) Anon. "Radio Proximity Fuze," *National Bureau of Standards Technical News Bulletin*, Vol. 31, Jan. 1947, pages 3-8 [11 illus.]

(3) Anon. "Printing Electric Circuits," *Instruments*, Vol. 20, April 1947, pages 366-367.

(4) A. V. DeForest, "Characteristics and Aircraft Applications of Wire Resistance Strain Gages," *Instruments*, Vol. 15, April 1942, pages 112-114, 136 137.

(5) Anon. "Vacuum-tube Acceleration Pick-up," *Instruments*, Vol. 20, Feb. 1947, pages 118-120.

[6]F. Knoop, C. G. Peters and W. B. Emerson, "A Sensitive Pyramidal Diamond Tool for Indentation Measurements," *Bureau of Standards Journal of Research*, Vol. 23, 1939, pages 39-61.

Calibrating various types of instruments.

Organization of a Research Laboratory Instrument Department*

By PAUL G. EXLINE, Section Engineer, Gulf Research & Development Co., Pittsburgh, Pa.

So greatly does the instrumentation of a large research laboratory differ in purpose and function from that of a processing or manufacturing unit that the organization of an Instrument Service Department presents many unusual problems. Each laboratory will have problems peculiar to the industry or branch of industry which it serves. The organization of an Instrument Service Department in the Gulf Research and Development Company laboratory is described herein, but it is felt that the structure and operating principles can also be applied to those serving other industries.

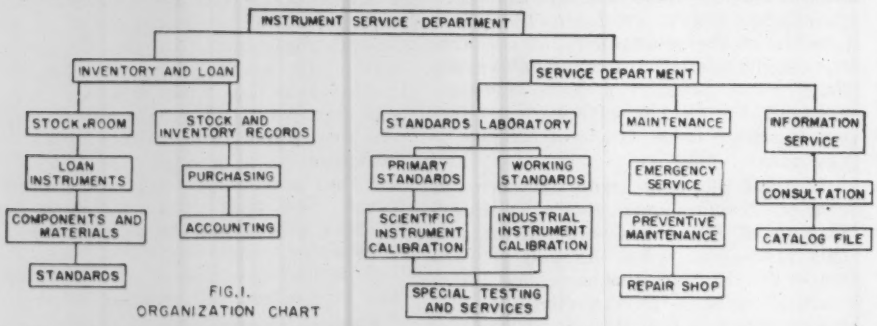


FIG. 1.
ORGANIZATION CHART

The research laboratory is characterized by the wide variety of instruments used and the caliber of the personnel using them. Although it may be departmentalized into a few functional divisions, there are many separate projects of various sizes, each under the responsibility of one or more specialists. This requires that the actual wants and needs of a large number of individuals must be satisfied, and the facilities and personnel of the instrument department must be versatile in the extreme.

The planning of the physical equipment of a refinery or large process plant must include the instrumentation, and a place is made for an instrument service department in the original organization. A research laboratory generally attains stature by a process of more or less gradual growth, and somewhere along the line the need for an instrument department becomes sufficiently acute to be recognized. During the growing period each worker is his own instrument man and, to a certain extent, he must always be so. Aside from the purely theoretical analyses, *almost the entire product of research is data obtained from measurements made with instruments.* The value of the research worker lies in the interpretation he makes of the data and in the measurements he decides are necessary. It is his responsibility that the instrumentation be right and the data correct. However, when the plant becomes large enough, operating economies can result from pooling the purely instrumental duties, and some of the research worker's responsibilities can be delegated to a competent Instrument Department.

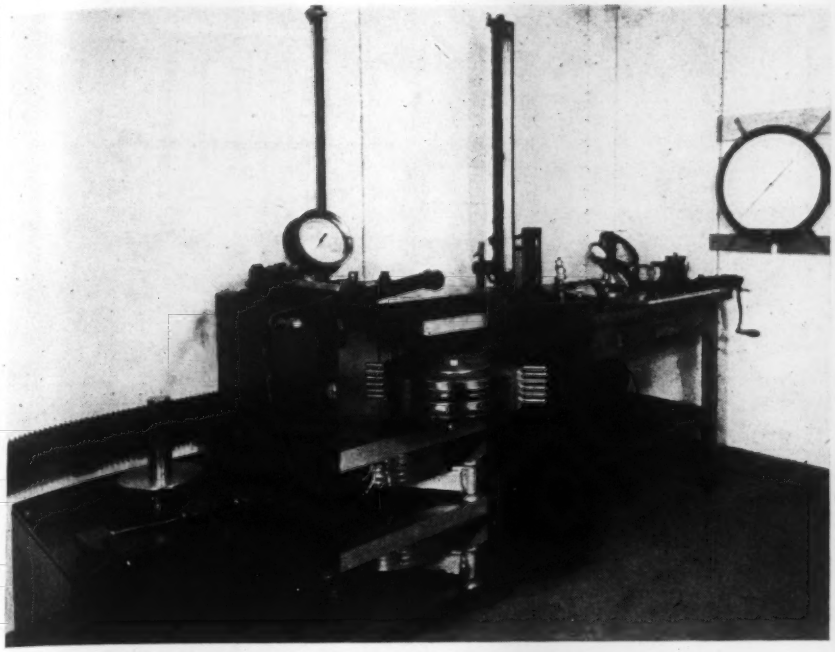
In organizing the Instrument Department, several guiding principles must be adhered to as rigidly as possible:

1. The Department must provide SERVICE: as if it were operating against the keenest of competition.
2. It must stay strictly within its own bounds and not encroach on the territory of the research worker.
3. It must have the confidence and support of those it serves.
4. It must have the confidence and support of management.

The block diagram, Fig. 1, shows the Department divided into two groups: the Inventory and Loan Group which is largely clerical, and the Service Department which is principally of a technical nature. That the two groups and their sub-divisions are closely

*Presented at the first Annual Conference of the Instrument Society of America, William Penn Hotel, Pittsburgh, Penna., Sept., 16-20, 1946.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.



Portion of pressure-gage calibration facilities. 10,000-lb./in.² dead-weight tester in foreground.

interrelated will be brought out as they are discussed individually. The relative size of each subdivision will depend largely upon the size and nature of the laboratory. In some cases the stock room will far over-balance the other groups and maintenance can be almost neglected. In this Laboratory the emphasis is on maintenance and calibration.

Inventory and Loan

This group includes the stock room and its close relative, the inventory record. It should be unnecessary to point out the importance of keeping an accurate record of each instrument and its location. The value of maintaining a well-indexed catalog of library books and a librarian who can locate any book within minutes is universally recognized. That similar control over instruments aggregating many times the value of the library books is economically justifiable can be demonstrated repeatedly. In many cases expensive instruments have been passed through so many hands that hours are lost trying to relocate them. Parts become lost, minor repairs are neglected, and in far too short a time a fine instrument can become virtually worthless.

Various systems are satisfactory for cataloguing instruments; we have found that the Kardex visible index file is adequate for our purpose. A sample inventory card is shown in Fig. 2. On the left-hand side of the card are spaces for the instrument number, its type, range, make, model, serial number, purchase information, location of instructions, and its normal location in storage. On the right-hand side is space for the data of each calibration and the calibration number.

The two bottom lines are the only ones visible as the cards lie flat in the trays. The instrument number, name and range are repeated here for ready reference. Two series of numbers are also visible which are used when the instrument is out of the stock room. The first series corresponds to the days of the month and will tell when the instrument is due for return by slipping a colored marker over that date. Each day the record clerk notes all instruments whose markers are covering that date and calls the borrowers of the instruments. The second series of numbers, 1 to 10, is similarly used to indicate the location of the instrument, a marker over the first number showing that the instrument is on the stock room shelves and available for immediate loan.

The back of the card has space for entering the name and location of the borrower and the date the instrument was borrowed.

If the Department is organized after

NUMBER | TYPE OF INSTRUMENT | L-185

CALIBRATION

RANGE

MAKE

DATE

MODEL STYLE NO | SERIAL NO.

SUPPLIER

COST | REQ. NO

RATE

INSTRUCTION INFORMATION

REMARKS

STORAGE SPACE

NUMBER	DESCRIPTION OF INSTRUMENT	RANGE	DEPARTMENTS									
1 2 3 4 5	6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21	22 23 24 25 26 27 28 29 30 31	1	2	3	4	5	6	7	8	9	10

Fig. 2

Electrical-component calibration and repair bench at left; workbenches for minor repairs in background.

the laboratory has been operating for a considerable time, it is necessary to make an exhaustive inventory in order to set up the index. At this time the identifying numbers are attached to the instruments as they are catalogued. The inventory must be made under the close supervision of one familiar with all types of instruments so that the cards will be filled out completely and accurately. After the system has been set up it must be kept up to date religiously by properly entering each new instrument as it enters the laboratory.

Adequate control can be maintained only if all instruments enter the laboratory through the Instrument Department. This not only gives ample opportunity for securing correct data for the inventory record but also enables the Department to inspect and calibrate the instruments before they are placed in service.

It should be pointed out that it is very important to have a uniform system of naming and classifying instruments so that they may be easily

TABLE I—CLASSIFICATION OF INVENTORY RECORD

Gas Flow & Volume Measurement
- Anemometer
- Dry Gas Meter (75-lb. WP)
- Flowmeter
- Gasometer (2 liter)
- Orifice (adj. thin plate)
- Velometer
- Wet Test Meters
- Rotameters

Length & Position Measurement
- Cathetometers
- Dial Indicators
- Gage, Depth
- Level, Precision
- Micrometers

Mass & Force Measurement
- Balance, Jolly
- Balance, Analytical
- Balance, Heavy Precision
- Proving Ring
- Scales, Beam
- Scales, Spring
- Weights, Precision

Optical Equipment
- Comparators
- Microscope Components
- Microscopes
- Optical Lever
- Prisms
- Refractometer
- Telescopes

Pressure Measurement
- Barometers
- Dead Weight Testers
- Gages, Differential
- Marometers, Absolute
- Manometers, Absolute Zimmerle
- Manometers, Dial
- Manometers, Differential
- Manometers, U-tube
- Manometers, Well Type
- Regulators, Pressure

Speed Measurement
- Speedometers
- Strobotacs
- Stroboluxes
- Tachometers, Absolute
- Tachometers, Autosyn Chrono-
- Tachometers, Chronometric
- Tachometers, Hand
- Tachometers, Indicating

Temperature Measurement
- Thermometers
- Thermostats

Heating Equipment
- Furnaces
- Hot Plates
- Ovens

Time Measurement
- Clocks, Electric
- Stop Clocks
- Timers, Cyclic
- Timers, Interval
- Stop Watches

Gas Detecting & Analyzing
- Carbumeters
- CO_2 Measuring Meters
- Mask, Gas
- Mask, Organic Vapor
- Mercury Vapor Detector
- Methane Detector
- Orsat Apparatus
- pH Meters
- Soil Gas Analyzer

Torque Measuring Equipment
- Balance, Torque Measuring
- Torquemeter

Viscosity Measuring Equipment
- Viscometers
- Viscometer, Mud

Laboratory Equipment, General
- Centrifuges
- Colloid Mill
- Combustion Bomb
- Fans
- Filters
- Lamps, Ultraviolet
- Liquid Separators
- Pelletting Machine
- Speed Reducer
- Shaker
- Stirrers

Electrical Measurement, General
- Microammeters, d.c.
- Milliammeters, a.c. and d.c.
- Millivoltmeters, a.c. and d.c.
- Ammeters, a.c. and d.c.
- Voltmeters, a.c. and d.c.
- Wattmeters, a.c. and d.c.
- Watthour Meters
- Recording Ammeter
- Recording Voltmeters
- Recording Wattmeters
- Circuit Testers:
  - Continuity Meters
  - Ohmmeters
  - Industrial Circuit Testers
  - Volt-ohmmeters
- Growlers
- Insulation Tester
- Bridge Testers:
  - Conductivity Bridge
  - Impedance Bridges
  - Wheatstone Bridges

Small-parts cabinets; record desks; Kardex, etc.

Electrical Measurement, Precision
- Galvanometers
- Galvanometer Accessories
- Potentiometers, Type K
- Potentiometers, Portable
- Potentiometer Scale Expander
- Resistance, Damping Coil
- Resistances, Standard
- Shunts, Instrument
- Shunts, Precision
- Standard Cells, Portable
- Volt Box

Electrical Accessories
- Capacitors, Decade
- Capacitors, Variable
- Inductors, Self
- Inductors, Variable
- Resistors, Decade
- Rheostats, Motor Control
- Rheostats, Precision Potentiometer
- Rheostats, Slide Wire
- Transformers
- Voltage Regulators

Electrical Test Equipment
- Amplifiers
- Audibility Meter
- Batteries, Storage
- Chargers, Battery
- Demagnetizer
- Dwell Indicator
- Filter, Wave
- Filter, Detonation
- Generators, Signal
- Generator, Square Wave
- Head Phones
- Microphones
- Oscillators
- Oscillographs
- Output Meter
- Power Packs
- Rectifiers
- Vibration Detecting and Meas'g Equip't
- Voltage Divider

Industrial Type Instruments
(205 instruments listed, including in any combination functions of control, indication, and recording)
- Flow Measuring
- Level Measuring
- Knock Meter
- Potentiometers
- Pressure Measuring
- Temperature Indicators (bulb types)
- Temperature Indicators (millivoltmeter)
- Time Measuring and Timers

found in the index. One fully-qualified person should be responsible for this in order to avoid confusion. It has been our experience that a straight alphabetical index is cumbersome and easily leads to errors. An outline of the functional classification now in use is given in Table I.

Accounting

The accounting duties of the Instrument Department are relatively simple. Each individual makes out a weekly time card showing the distribution of time on various projects. Time may be charged either against general work in the Instrument Department or against specific research projects for which instrument service is performed. Before the cards are sent to the laboratory Accounting Department the total hours worked on projects in the different operating divisions and the total hours spent on the different classes of work in the Instrument Department are taken off for the purpose of making a monthly report of such time distribution. This serves to give a continuous indication of the efficiency of operation of the Department.

Material and supplies and instruments for stock are purchased against appropriate inventory account numbers depending upon whether or not they are plant items to be depreciated over a period of years. When such materials are taken out for permanent installation or complete consumption, a Material Requisition form shown in Fig. 3 is filled out giving the account number of the project on which they are used. A monthly summary of these charges is sent to the Accounting Department for crediting to the inventory accounts.

The same procedure is followed in giving credit for instruments returned from installations—instruments which had been expected to be out permanently.

No charge is made for instruments or equipment taken out for short-time loans except for the time necessary to restore them to first-class condition after use. For this reason the Instrument Department always operates at a loss which represents an overhead charge on all the operating divisions of the Laboratory. A rental charge could be computed for each instrument which would include all factors such as expected life, calibration cost, clerical overhead, etc. The bookkeeping involved in such a system could not be economically justified as the gain in more accurate allocation of project costs would be hardly perceptible.

INSTRUMENT SECTION COPY

L-202 No.

MATERIAL REQUISITION

PROJECT _____ DATE _____

QUAN.	DESCRIPTION	COST

SIGNED _____

Fig. 3. Material Requisition Form, made out in triplicate, one copy being used for monthly summaries.

L-212

INSTRUMENT SERVICE REPORT _____ NO _____

FROM _____ DATE _____

TO _____ PROJECT _____

INSTRUMENT IDENTIFICATION _____

LOCATION _____ SERVICE REQUESTED BY _____

WORK REQUIRED _____

_____

_____

_____

_____

_____ HOURS _____

CAUSE OF TROUBLE _____

_____

_____

PREVENTIVE MEASURES _____

_____

NOTED BY _____ RETURNED _____

Fig. 4. Instrument Service Report Form, made out in duplicate, retained copy being used for periodical analyses.

Stock Room

The facilities of the stock room should be adequate for storage of all instruments which may be in stock at a given time. Too-crowded storage shelves result in loss of time and occasional damage. All cabinets and shelves should be plainly numbered so that the stock clerk need not rely on memory for quickly locating an instrument.

If the Instrument Department is organized after the laboratory has been in operation for a number of years, there will always be found some individuals who have a proprietary interest in the instruments they have purchased themselves and who are reluctant to relinquish such instruments to the general stock room. Such prejudices can usually be overcome when those involved can be assured that the instruments will be kept properly and will be available when the need arises. It is quite important that such assurances be scrupulously kept. It is not infrequent that lack of an instrument can cause a loss of time amounting to more than the value of the instrument.

It is also necessary that the research worker inform the Department of his needs as far in advance as possible so that arrangements can be made to secure the proper equipment.

The stock room must provide instruments for such a wide range of applications that a thorough study of the needs of the laboratory is an essential prerequisite to its establishment. Before a purchase order is written, the frequency of requests for special instruments should be integrated over a period of time and those interested consulted regarding probable future uses.

When an instrument is borrowed, the date and the name and location of the borrower are entered on the back of the inventory card. The date marker is shifted to indicate the expected time of return and the location marker moved to the position indicating the building or section to which the instrument is taken. Upon return of the instrument, the stock-room clerk makes the appropriate notations on the record card and turns the instrument over to the Service Department for examination and calibration. Any work done on the instrument is charged against the project on which it was last used. It is then returned to its proper place on the shelves.

Components and Materials Stock

In a research laboratory many temporary and permanent experimental set-ups are fashioned by the workers. The "string and sealing wax" of the traditional experimental physicist must be supplemented by a wide variety of

materials which are readily available. Some of these are truly instrument components but many others might fall into the gadget class. A list of such items is shown in Table II. It is debatable whether some items properly belong in an Instrument Department and many laboratories will carry a number of such items in their general stock room.

The records of the components and materials stock are also kept in a Kardex visible index file. Each card has the name of the item and its cost typed along the bottom edge where it is visible as the cards lie flat in the trays. Space is provided for entering the maximum and minimum number of items which should be carried in stock. The date of removing one or more of an item is entered on the card and the number removed subtracted from the number previously shown to be in stock. When this falls below a minimum number shown on the card, enough additional items are ordered to bring the stock back up to the maximum number.

TABLE II
COMPONENTS AND MATERIALS STOCK

Stock Class	Number of Different Items
Adapters, Loktal	3
Aluminum Sheet Stock (0.003"-0.005")	2
Batteries, Dry Cell	13
Bearings, Miniature Ball	12
Binding Posts	3
Bulbs (pilot light & special application)	38
Cable	8
Capacitors	50
Ceramic Tubing	15
Chart Paper	26
Chassis & Boxes	7
Clamps, Battery	9
Clamps, Cable	4
Clamps, Tubing	10
Copper Mesh Screen	3
Counters	8
Electric Indicating Instruments	45
Electrical outlet sockets, plugs, cable connectors, etc.	91
Flasks, Dewar	1
Fuses & Fuse Holders	46
Grid Clips	3
Grommets	8
Handles, Ball Crank	1
Heaters	25
High Pressure Fittings	8
High Pressure Fitting Tools	3
Inks, Recorder	15
Instrument Feet	1
Insulation, Asbestos	1
Lamps, Misc.	2
Oils, Industrial Instrument	2
Oscilloscope Tubes	3
Paint, Temperature-indicating	12
Pilot Lights	18
Radio Tubes	78
Relays	47
Resistors	164
Spaghetti (Insulation)	11
Switches	42
Switches, Mercury	8
Tape, Asbestos	1
Tape, Friction	1
Tape, Glass	4
Tape, Rubber	1
Terminal Strips	7
Thermocouple Wire	26
Thermometers	23
Tubing, Asbestos	1
Tubing, Woven Glass	6
Valves, Hoke	4
Valves, Magnetic	1
Variacs	5
Vibration Dampers	1
Wire, Heater	6
Wire, Hook-up	35
Service Stock—Parts and Accessories for:	
*Brown	20
Esterline Angus	1
*Foxboro	8
*Leeds & Northrup	35
*Mason-Neilan	20
Sun-Timing Light	6
*Tagliabue	25
Wet Test Meters	11
TOTAL ITEMS	1094

*Includes several range changes.

A Material Requisition form, shown in Fig. 3, is also filled out, in triplicate, at the time of removal of material stock. The unit cost of each item is looked up in the visible index and the total entered on the form before it is removed from the register. One copy is given to the person signing for the material, one copy is sent to his section head, and the third is used for making out the monthly summary of project charges for the Accounting Department.

SERVICE DEPARTMENT

The Service Department is divided into three highly important and specialized groups: the standards laboratory, the maintenance group, and the information service.

Meter prover set up for rotameter calibration. At right, precision 2-liter gasometer.

Standards Laboratory

It is the function of the standards laboratory to maintain an adequate supply of primary and secondary standards, and facilities for using them, so that any instrument can be checked to the required accuracy. It was mentioned before that the principal products of a research laboratory are data obtained through the use of instruments. The utmost importance is attached to the knowledge of the accuracy of the measurements in interpreting their meaning. Table III gives a list of the standards which are regularly used.

Little emphasis is given in this list to length standards. This Laboratory maintains a large instrument shop of unusually high standards. This shop maintains an inspection department with length standards sufficient to cover a wide range of dimensional inspection. For this reason it is unnecessary to duplicate such equipment in the Instrument Department.

The facilities of the standards laboratory should be such that permanent calibration-stands are available for the more frequent services. In this Laboratory this includes calibration of pressure gages, gas meters and flow-rate indicators, thermometers, thermocouples, large precision weights, a-c and d-c. electrical instruments and resistors. It is hardly necessary to describe these facilities in detail. Descriptions of precision calibration equipment of various types can easily be found in the literature and in manufacturers' catalogs.

Occasionally the facilities of the standards laboratory may be required in research work which cannot be easily done elsewhere in the Laboratory. This is especially true where constant temperature conditions are required. Special arrangements can usually be made for such work when it is of such a nature as not to interfere with the routine work.

Instrument Maintenance

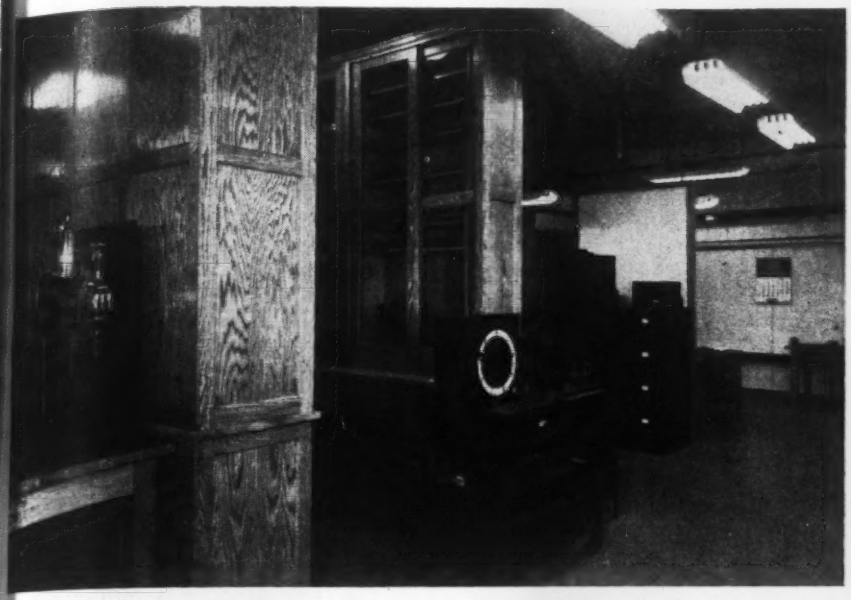
Because of the nature of this Laboratory, it is necessary to maintain extensive pilot plant operations and new process development where the instrumentation problems are similar to those of a refinery. Unlike a refinery, failure of an instrument can result in much more than product spoilage; it may cause the loss of a test involving thousands of dollars in labor and materials. For this reason an emergency instrument service must be available at all times.

Providing service only to those instruments giving trouble is an expensive and uneconomical procedure. All installed control and recording instruments should receive the benefits of a well-planned preventive maintenance program. This will not only minimize the emergency service required but will do much to minimize the possibility of loss of expensive tests.

The maintenance program should provide for periodic attention to all installed instruments. This includes general inspection, battery replacement, replacement of worn parts, and inspection of installation conditions. By keeping records of all service calls to instru-

TABLE III
PRIMARY AND SECONDARY STANDARDS

1. *Mass*
   - Class B standards from 0.5 lb. to 20 lb.
   - Analytical weights, 10 mg. to 100 g.
   - Precision balance, 25 kg. capacity
   - Laboratory balance, 1.5 kg. capacity
2. *Length*
   - Precision cathetometer, 1-m. range
3. *Force*
   - Morehouse proving ring, 50,000-lb. capacity
4. *Pressure*
   - 10,000 lb./in.2 piston gage
   - 2,000 lb./in.2 piston gage
5. *Gas Volume*
   - 5 cu. ft. meter prover
   - 0.1 cu. ft. bottle
   - 0.15 cu. ft. gasometer
   - 2 liter gasometer
6. *Thermometric*
   - Set of certified thermometers covering range from —60°F. to 600°F.
   - Mueller bridge and resistance thermometer
7. *Pyrometric*
   - Platinum-platinum rhodium thermocouple with precision potentiometer
8. *Electrical*
   - Standard cells
   - Resistors
   - Precision d-c. potentiometer with volt box
   - Certified a-c. ammeter and voltmeter
   - Anthony bridge



Portions of storage facilities and of office space.

ments the proper frequency of attention for the different applications can be determined.

Emergency service generally follows a call for assistance by one of the operators. Such a call will usually be taken by the record clerk who will enter the necessary information on the Instrument Service Report form shown in Fig. 4. This is then turned over to the service engineer who completes the form after correcting the trouble. This form is made out in duplicate with the carbon copy on cardboard retained for periodic analysis to determine most frequent causes of trouble, types of instruments giving the most difficulty and to provide a basis for improving the maintenance service. The first copy is sent to the Section Head having jurisdiction over the instrument serviced, in order to keep him informed of instrument performance and to help him maintain efficient operation.

In experimental pilot plant operation relocation and change of instruments is much more frequently done than in a process plant. This should always be done by or under the supervision of the Instrument Engineer. This course permits correct installations from the start and insures use of the correct instrument for each application.

Coöperation between the chemical engineers and operators and the Service Department cannot be overstressed. On the one hand, competent service must be available when needed, since good service will keep operators from trying to fix the instruments themselves. On the other hand, the operator having confidence in the service will call for help at the first symptom of trouble, not after he finds that he cannot effect the repairs himself. If this is attempted, the damage done by unskilled efforts is often worse than the initial trouble.

Particular attention must be paid to the dividing lines between the work of the instrument service man and that of the pilot plant operators and their supervisors. Primarily, it is the duty of the engineers and chemists to specify the instrumentation and its installation, while the instrument service man must accept the responsibility of its subsequent successful operation. There are many special conditions and nonstandard applications that make this divided responsibility necessary. This places a heavy burden on the instrument service man—not only on his technical ability but upon his tact and diplomacy. While his duties are restricted to the instrument itself, he must know good installation practice and its relation to control of various processes. He must be ready at all times to advise the operators on how best to fit the installation to the process.

Repair Shop.—An elaborate repair shop will rarely be necessary. Because of the great range of instruments used, it is not economically justifiable to set up facilities and develop skills for major repairs on all of them. All such work can be much better done by the manufacturers. Occasionally, where large numbers of a single type of instrument are used, it may be of value to make provisions for more extensive repair and overhaul work. As an example, this Laboratory uses large numbers of wet test meters, many of them under conditions which are extremely deleterious. Arrangements were made with the machine shop for them to send a machinist to the manufacturers' shops to learn the correct overhaul and repair procedures. Now, when the Instrument Department discovers such a meter in need of repair, it is sent directly to the machine shop for a complete overhaul, thus limiting the work of the Instrument Department to inspection and calibration. This arrangement permits the work to be done by an experienced shop man who has available all the tools of a fully-equipped machine shop. An attempt to do this in the Instrument Department would require a large investment in equipment which would be idle most of the time.

Information Service

A consulting service is available for assistance in all matters pertaining to instruments. This includes basic information on the applications and limitations of instruments, assistance in specifying instruments for particular applications, providing data on the properties of various materials, and the like. Because of the large number of individuals, this service requires a surprisingly large amount of time. Much of it is purely educational and must be repeated over and over to individuals applying similar techniques to different problems in various divisions.

An excellent educational opportunity can be secured by issuing occasional technical bulletins describing in simple terms the applications, scope and limitations of instruments and components. The need for such bulletins can be seen from the amount of duplicated questions coming to the service group. They can be directed to all those known to be interested and a stock kept on hand for future use.

A complete catalog file is maintained to make available current information on all instruments and related supplies. Contacts must be kept up with local suppliers and possible delivery schedules carried in mind.

This work requires a thorough knowledge of instruments and the ready availability of a complete reference library to supplement the catalog information.

It is necessary to limit the field of consultation since, in many cases, it could develop into specialized work well beyond that lying within the field of instrumentation service. For example, a request for information on electrostatic voltmeters should not require an investigation of the application to determine the influence of current drain to the voltmeter on the behavior of the device. An accurate and complete description of the available voltmeters should be sufficient. As a general rule, consulting engineering should be avoided while adhering strictly to instrument service.

Conclusion

An attempt has been made to outline the salient points of an Instrument Department in a research laboratory without much description of facilities or discussion of the problems involved. The operations of a research laboratory are quite different from those of a process plant and the Instrument Department must be organized to cope with these differences.

Acknowledgments. The author wishes to thank Miss Louise Suckfield, and Messrs. W. K. Bowman and Paul Conrad for helpful suggestions during the preparation of this paper, and Dr. Paul D. Foote, Executive Vice President, Gulf Research & Development Company, for permission to publish it.

Requirements for Dynamic Test Equipment in Certain Aircraft Applications*

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THIS article concerns those requirements for dynamics test equipment which have been established primarily on the basis of performance of this type of equipment under service conditions. The requirements are not listed explicitly but are indicated in a general way by a discussion of the limitations of present equipment utilized for aircraft dynamic testing. To indicate the steps taken to obtain improved equipment an approximately chronological outline will be presented of the development and procurement of dynamic test equipment for use by the Flutter Unit, Dynamics Branch of the Aircraft Laboratory of the Air Matériel Command. Responsibilities of this unit include the measurement of two different types of phenomena, namely: flutter oscillations and impact loads, pertaining to aircraft structures and components. Aircraft structural oscillations measured in flutter testing have a definite period but have amplitudes which vary as a function of time such as damped oscillations (transients) and unstable oscillations in which the amplitude increases with time finally reaching a steady-state amplitude or causing structural failure. Impact loads on the other hand consist of a combination of transients of different periods plus static phenomena such as strains and accelerations in aircraft structures during landing, cannon-recoil loads, pressure pulses in hydraulic systems and glider tow loads.

The original responsibility of the Flutter Unit, as indicated by the name, was primarily flutter prevention. In the conventional aircraft structure, flutter oscillations have frequencies which are generally in the range from 3 to about 40 cps. while the amplitudes encountered in "safe" tests vary from about 0.03″ at the high frequency to 2″ or 3″ at low frequencies.

The type of equipment commercially available at the start of the experimental flutter program was not suited for the work. This equipment consisted of velocity pick-ups with natural frequencies of about 7 cps., integrating amplifiers having a proper frequency characteristic from 3 to about 2000 cps. and a 4-channel recording oscillograph with elements having natural frequencies of approximately 2600 cps. The primary limitation of this equipment lay in the pick-up units whose characteristics were questionable over the lower part of the frequency range of flutter oscillations. The amplitude limitations of the pick-up, friction in the support of the seismic system, transient responses of the seismic system and large static deflections of the seismic system in acceleration fields were undesirable features for flutter testing.

For these reasons a cantilever-beam-type fluid-damped strain-gage accelerometer was developed for use with this equipment in conjunction with a single-stage preamplifier. The accelerometer circuit consisted of two 15,000-ohm wire strain gages (measuring the beam bending) excited by a 90-volt B battery with the common strain-gage connection coupled to the preamplifier by means of a capacitor (Fig. 1). This

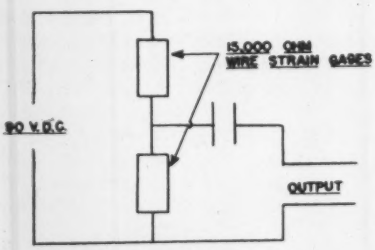

FIGURE 1
STRAIN-GAGE ACCELEROMETER CIRCUIT

equipment was found to be reasonably satisfactory but had the following disadvantages:

The accelerometers had to be calibrated before and after each test in order to insure that the cement bond of the strain gages was satisfactory. (In most cases the calibration factors remained constant over long periods of time). In addition, temperature had an appreciable effect upon the response of the accelerometer despite the fact that the viscosity-temperature curve of the fluid used was reasonably flat.

The recording oscillograph also gave some trouble: bubbles of the galvanometer damping oil often formed in front of the galvanometer mirrors as a result of temperature change and the resistances of the galvanometer fuses changed appreciably, reducing the galvanometer current. The first of these difficulties was inherent in the galvanometer design since the damping oil surrounded the galvanometer mirror. The second problem was important because of the low resistance of the galvanometer and was caused by temporary overloading of the galvanometers. This overloading could not always be avoided by proper setting of the gain control in view of the amplitude-time characteristic of flutter oscillations. The use of a neon overload indicator in this equipment was of considerable help, however, in setting the gain controls and is an excellent feature.

In order to obtain more satisfactory equipment, contracts were let for the procurement of carrier equipment with reluctance type magnetically-damped accelerometers and magnetically-damped galvanometers. The equipment included circuits for single and double integration of the accelerometer output to give vibration velocity and displacement respectively. These circuits were considered important because high-frequency vibrations of small amplitude caused by the engine, propeller, and airflow often cause accelerations of the same order of magnitude as low-frequency oscillations encountered in flutter testing. Performance data for this equipment were approximately as follows:

(a) 4″ record amplitude per g acceleration—flat from 0 to 35 cps.

(b) 300″ record amplitude per inch displacement—flat from 1½ to 35 cps.

The equipment was unfortunately very bulky, being approximately 1600 in.^{3} in volume and 32 lbs. in weight per channel (excluding the oscillograph). While it gave satisfactory results in some tests, certain troubles were encountered, many of which were inherent in the detail design. Some of these were:

(a) Failure of internal accelerometer structure when accelerometer was installed on an engine.

(b) Oscillator voltage drift.

(c) Poorly damped low frequency oscillations in the integrating amplifier stages.

(d) Ghost traces in the oscillograph caused by the use of two lamps.

(e) Blackening of the oscillograph lamps caused by overheating and resulting loss in light intensity.

(f) Oscillograph paper jams.

(g) Difficulty in adjusting galvanometer positions and timing system.

The low-frequency response of this equipment when used for displacement measurements, in combination with the poorly-damped amplifier oscillations, was disadvantageous for flight tests since motions of the aircraft as a rigid body resulted in larger record amplitudes than those caused by the oscillations in flutter tests. Another disadvantage was the use of plug-in cans for holding circuit components. These cans made it difficult to locate and repair troubles which were encountered and to modify the characteristics of the equipment for meeting requirements of special tests. Since only one set of equipment was procured, it was not considered economical to stock spare plug-in cans.

In view of the need for smaller and improved equipment, it was necessary to revise the basic requirements. These changes were as follows:

(a) The displacement sensitivity was reduced to 60 inches per inch.

(b) The flat frequency range was changed to 5 to 60 cps. on displacement and 0 to 60 cps. on acceleration.

(c) The use of fluid damped accelerometers was permitted to obtain higher natural frequencies and greater sensitivities. Magnetic damping was not practical with the heavy seismic masses and stiff supporting springs used.

*Presented at the first Annual Conference of the Instrument Society of America, William Penn Hotel, Pittsburgh, Penna., Sept. 16-20, 1946.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.

As a result, the volume and weight of equipment procured in accordance with the revised specifications were only 440 in.^{3} and 12 lbs. respectively per channel, excluding the oscillograph. This equipment proved more satisfactory than the preceding type but also gave trouble, the more serious being:

(a) Unbalance of the accelerometers caused by distortion of the case when the accelerometers were attached to rigid structure.

(b) Variation in the accelerometer performance with temperature; the sensitivity was reduced by a factor of 3½ at 2400 cpm. when the temperature was changed from 79°F. to —20°F.

(c) Failure of the accelerometer external leads which were relatively fine wire covered by thin insulation (rubber covered shielded cable gave no trouble in the preceding equipment).

(d) Zero drift of the accelerometer equivalent to about 0.3 of a *g* per 25°F. change.

(e) Failure of accelerometer internal leads when installation was made on an aircraft engine.

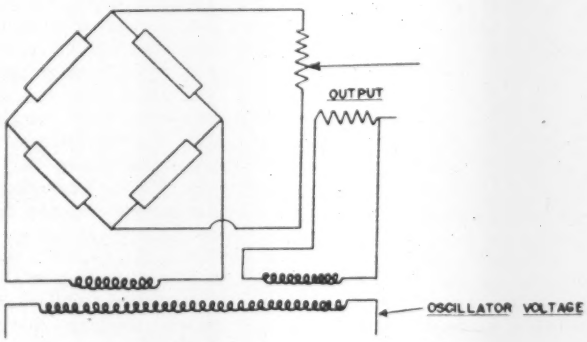

FIGURE 2

A.C. BRIDGE WITH CARRIER INJECTION

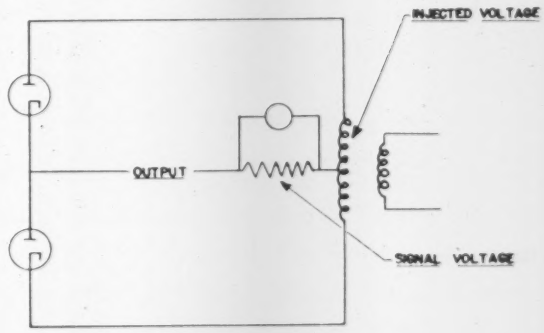

FIGURE 3

PHASE DISCRIMINATING DETECTOR

(f) Oscillograph paper jam.

(g) Oscillograph timing system failure when B-battery was used. (B-battery was later replaced by a vibro-pack).

The troubles experienced with the above types of equipment can be largely rectified by more emphasis on detail design and recognition of the necessity for ruggedness and dependability in aircraft test equipment, particularly in accelerometers.

In addition to the advantage of small weight, the smaller equipment had an improved system of demodulation in the amplifier. The original equipment used a straight carrier injection scheme (Fig. 2) after the gain control so that a d-c. voltage is imposed on the galvanometers and has to be balanced out. In addition the injected voltage has to be in phase with the signal voltage or the output will not be a linear function of the signal. The later equipment used two half-wave detectors arranged so that the output was the difference of the detector outputs (Fig. 3). The voltage on one detector is the sum of one-half the injected voltage plus the signal voltage while that on the other detector is the difference between one-half the injected voltage and the signal voltage. With no signal there is thus no output and in addition the quadrature component of the signal voltage gives no rectified signal output since the output voltage reverses during each half-wave. Thus, the quadrature component of the bridge voltage does not have to be balanced, permitting the use of a single bridge balance control unless the phase unbalance overloads the detector and/or preceding amplifiers. Moreover the injected voltage does not have to be exactly in phase with the signal voltage for linearity, the only effect being a reduction in sensitivity. This type of rectification is now a requirement on all carrier equipment with the modifications that:

(a) Full-wave rectification with copper-oxide or selenium rectifiers and transformer inputs are required for increased power.

(b) A screw-driver phase balance control is incorporated in the bridge to reduce phase unbalance when necessary.

(c) The phase of the injected voltage is controllable to insure maximum sensitivity with all types of pick-up units.

Some of the more fundamental difficulty experienced with the equipment described above did not affect the accuracy obtained in flutter tests. The explanation lies in the fact that the only flutter data which need be measured accurately are: the relative amplitudes of vibration of the various components involved, the relative phase relationships and the flutter frequency. Since flutter oscillations take place at a definite frequency, the only basic requirement for accurate data is that all channels of the equipment have the same frequency and phase shift characteristics. The major source of error in flutter measurements proved to be the "hash" on the records caused by engine, propeller, and airflow disturbances. In practice it was found that the use of an integrating circuit was a satisfactory solution to the hash problem.

The accuracy of the results obtained with the above type of equipment in impact load testing was less satisfactory. In this type of testing, absolute magnitudes and wave shapes are important data so that the frequency and phase shift characteristics must be given more consideration. Reasonable requirements for such equipment are a flat frequency response plus proportional phase shift from zero to the highest frequency component to be recorded and about 0.7 critical damping for all seismic systems. The important frequencies in various types of dynamic tests were found to lie in the following ranges:

(a) Landing load tests—below 20 cps.
(b) Pressure pulse tests—below 100 cps.
(c) Cannon recoil tests—below 200 cps.

(In the cannon recoil tests, a pulse was recorded which had a period of about 70 milliseconds and the frequency was estimated on the basis of the slope of the beginning of the pulse.) The need for a response to zero frequency is based on those cases where a combination of static plus dynamic phenomena are to be measured such as in landing load and hydraulic tests. When the complete phenomenon is over in a relatively short period, a zero frequency characteristic is not required. However, there will be superimposed on the signal voltage an output caused by discharge of capacitors and loss of d-c. flux from transformers if there is appreciable phase shift in the equipment at the lowest frequency to be recorded. Another effect which has occurred is the excitation of very-low-frequency transients (damped motorboating oscillations) in the amplifiers. These transient effects are not too serious if their period is long compared to that of the pulse.

The problem of phase shift or time delay in dynamics measuring equipment has been the subject of considerable discussion. For steady-state oscillations this time lag is not a serious problem since the wave-shape reproduction will be perfect as long as all frequency components are reproduced with the same time delay and same magnifications. The first condition is obviously satisfied by a phase shift proportional of frequency. Under transient conditions, the effect of phase shift is to distort the shape of the beginning and end of the pulse by transient vibrations of the pick-up unit and galvanometer which will prove serious if there is insufficient damping in the seismic systems. Consider for example an acceleration pulse made up of half of a sine wave of such a frequency that there is considerable phase shift between the applied acceleration and the pickup response under steady state conditions. At the start of the pulse, the steady state condition requires finite values for the velocity and displacement of the seismic elements of the accelerometer and galvanometer, while actually these values

must be zero. To satisfy this latter condition there is superimposed on the pulse free vibrations of the seismic elements (Fig. 4). (Free vibrations also occur at the end of the pulse because of energy left in the seismic system). However, with seismic systems having approximately 0.7 critical damping, the peak transient response and peak steady-rate response do not differ appreciably in magnitude from the peak static response even when the frequency of the half sine wave pulse equals the natural frequencies of the seismic systems. However, under this condition, the steady-state vibratory response is only 70% of the static response so that it usually is not advisable to operate at frequencies above half the natural frequencies of the seismic systems. The only difference between the transient and steady state vibratory responses will then be a slight distortion of wave shape under transient conditions. If however, the damping is considerably less than 0.7 critical, appreciable trouble can be expected in transient measurements (Fig. 5).

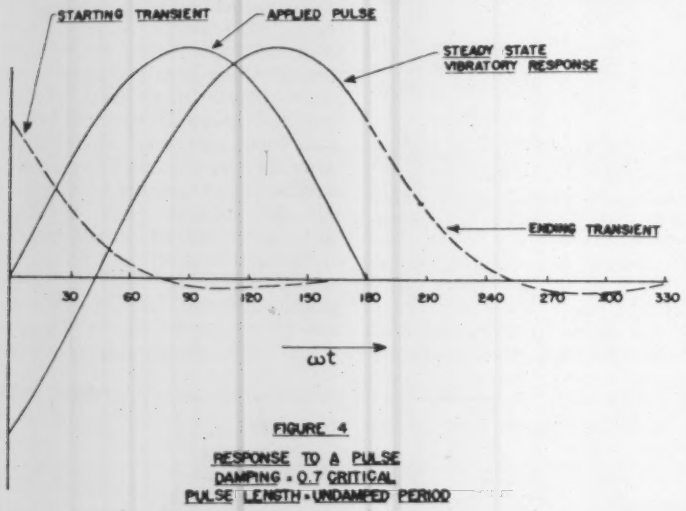

FIGURE 4
RESPONSE TO A PULSE
DAMPING = 0.7 CRITICAL
PULSE LENGTH = UNDAMPED PERIOD

The carrier type of equipment procured for flutter testing had a sufficient frequency range for the measurement of landing load phenomena such as landing-gear loads, acceleration of structural components, and structural strains. In addition, the range of the accelerometer units used for flutter testing ($\pm 15\ g$) was adequate for most of the measurements desired. In order to make full use of the equipment, it was only necessary to make modifications required for strain-gage applications. For the first type of equipment, the modifications required were an increase in gain and a change in the phase of the injected carrier, while in the second type of equipment it was only necessary to increase the gain. The resulting strain sensitivity in both cases was of the order of one-inch record amplitude for a strain of 250 microinches per inch.

The functioning of the equipment in actual landing tests was generally satisfactory even though certain problems showed up. These problems were:

(a) Hash on the accelerometer records caused by unimportant accelerations such as local structural vibration and engine propeller vibration. Low-pass filters having a cutoff at around 20 cps. were finally used to reduce the hash level coming from accelerometers located near the engines.

(b) Drift in the strain-gage channels. The drift was slow enough so as not to affect the accuracy of the data but was objectionable in that the equipment had to be continually rebalanced during the test. For tests in single-place aircraft, drift cannot be tolerated if it overloads the equipment.

(c) Stopping of the timing galvanometer in one oscillograph during hard landings.

(d) Difficulty in adjusting the gain controls to prevent crossing of the oscillograph traces in many records thus making it extremely difficult to identify the traces.

In one series of landing tests, a large number of channels of equipment had to be used to obtain the desired data. Actually 37 channels of equipment were used with four separate oscillographs. Upon analyzing the data, it was found to be very difficult to synchronize the records of the various oscillographs even though a synchronizing pulse was employed in each unit. The timing lines in the various oscillographs were not sufficiently accurate to permit synchronization from the single pulse and it was necessary to calibrate each timing system and correct for the differences which were of the order of 2% to 3%. The use of four oscillographs also resulted in somewhat of a personnel problem in that it was necessary to have three flight engineers to make sure that:

(a) All units were operating properly, i.e. that the oscillograph paper did not jam and the bulbs did not burn out.

(b) Drift in strain-gage channels associated with a particular oscillograph was balanced out and gain controls were set properly.

The obvious solution to the above problems was to have an oscillograph developed with 37 or more channels. There are on order now some 34-channel oscillographs with means for synchronization by operating the timing systems from a common oscillator or by a continuous synchronizing pulse. In order to make the oscillographs small enough for aircraft use, the trace amplitude will be kept below one-fifth of an inch and optical magnification will be used for record analysis. With such magnification, it was possible to reduce the paper speeds, thereby conserving paper and obviating the need for reloading in flight. These oscillographs will be equipped with a means for identifying traces, probably consisting of a light interrupter successively blacking or dimming the light from each galvanometer. Other features include a paper footage indicator operated by motion of the paper rather than motion of the driving rollers and an indicating light which will blink when the paper is in motion.

About the time the landing load test program was under way, the problem of measuring glider towing loads came up. This measurement differed from landing load measurements in that the equipment had to remain in balance during the entire test (about 2 hours) whereas for landing measurements the equipment could be rebalanced before the landing impact and had only to remain in balance for a few minutes. Ex-

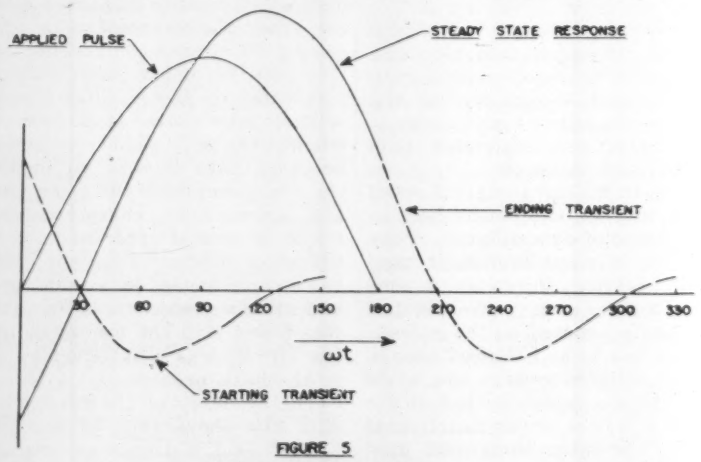

FIGURE 5
SAME AS FIGURE 4 EXCEPT
DAMPING = 0.35 CRITICAL

perience with carrier equipment indicated that it would not be suitable for such measurements because of its drift under flight test conditions. Fortunately, some 40 cps. galvanometers were on hand at the time which had sensitivities of around one-inch record amplitude for 30 microamperes input and thus these galvanometers could be operated directly by a d-c. strain gage bridge. With a four-active-arm 120-ohm strain gage bridge excited by 12 volts d-c., one-inch record amplitude was equivalent to a strain of 200 microinches per inch. This equipment gave excellent results in the glider tow load test, the only source of error being a thermoelectric current of about two microamperes. In fact, the operation was so satisfactory that it was decided to make use of d-c. bridges for all low-frequency and static strain measurements. It was recognized, of course, that the strain gages could not be used at full gain for landing tests because the low resistance provided too much electrical damping for the galvanometers employed.

The first attempt to use this equipment for landing tests ended in failure because of vibrations of the galvanometers caused by the landing impact. This problem was partly solved by mounting the oscillograph on shock cord. Later, an investigation was conducted regarding the response of galvanometer elements to landing impacts and it was found that the average single-vibration amplitudes of oscillograph elements per g of landing acceleration were:

(a) 0.3″ for 40-cps. elements.
(b) 0.2″ for 60-cps. elements.
(c) 0.1″ for 100-cps. elements.

All of the above readings were made with the oscillograph mounted on its regular base.

Fortunately, improvements have been made in oscillograph element design so that 160-cps. elements will soon be available having sensitivities of the same order of magnitude as the 40-cps. elements. The high frequencies of the elements will obviously reduce the effects of external acceleration as well as provide a wider frequency range for the measurements. The use of these galvanometers with d-c. bridges appears to be the most practical means of conducting aircraft structural flight tests, assuming the errors caused by thermal emf's are no larger than mentioned above. In order to minimize these errors the gain controls on the d-c. bridges being procured are specified as series and parallel bridge output resistances rather than resistors in series with the d-c. voltage. The latter method is simpler but does not reduce the thermoelectric current. A feature to be incorporated in the d-c. bridges is a balancing indicator since it was not convenient to balance by observing the galvanometer spots.

The d-c. bridge method of strain gage measurements will not cover all the needs of an aircraft dynamic test group. Hydraulic pressure, aerodynamic pressures, and cannon recoil loads may possibly involve higher frequencies than can be accurately recorded with this method even if strain-gage devices are utilized. Another limitation is the relatively low sensitivity compared to that possible with carrier equipment. In one case, it was necessary to measure a compressive stress of 1000 lbs./in.^{2} in steel to determine the magnitude of a component of a landing load. With two-active gages, the oscillograph record amplitude would be less than 0.1″ if d-c. bridges were used. Carrier equipment having approximately 10 times the sensitivity of the d-c. bridge equipment and providing a flat frequency response up to at least 300 cps. has thus been ordered. This carrier equipment will be designed to accommodate 4-arm strain gage bridges as it is understood that other testing groups have had no drift problems with their carrier equipment when they used strain gages to form the complete bridge.

Since suitable equipment was not available for measuring pressures in hydraulic systems and gun recoil loads when these data were needed, it was necessary to modify the equipment on hand to make these measurements. For hydraulic pressure measurements in flight, the equipment consisted of a tube wound with strain gage wire in combination with the bridge oscillator of a set of 1175-cps. carrier equipment plus a class A amplifier operating a four channel oscillograph with 2600-cps elements. The record was a modulated wave whose amplitude was proportional to pressure. Unfortunately, the drift of this equipment was so great that the hydraulic pressure in the gage had to be continually reduced to zero in order to rebalance before each test. For this reason, the equipment was just barely satisfactory. Laboratory tests indicate that the drift problem is not likely to be as serious, however, with the reluctance type of pressure gages which have recently been developed.

For the cannon recoil tests, strain gages were used with two different types of equipment:

(a) Carrier equipment with a modified output circuit to operate 200-cps. galvanometers.

(b) The standard 3-2000-cps. equipment used for vibration testing in conjunction with the type of strain gage circuit used with the strain-gage accelerometers previously described.

The results with the two sets of equipment agreed with respect to waveshape but not in magnitude. It was suspected that something was wrong with the installation and/or calibration of the strain gages. One interesting point learned from the tests was the fact that the transient characteristics of the 3-2000-cps. equipment did not appreciably affect the shape of the pulse which was of about 70 milliseconds duration.

While the carrier equipment now on order should prove satisfactory for the tests mentioned in the three preceding paragraphs, some possibilities of trouble still exist, namely:

(a) *Oscillator voltage change with time.*—Some cases were observed where the oscillator voltage changed by about 20% as a result of faulty tank circuit components in one case and what was considered to be corrosion from moisture in the other case. Corrosion protection is now a requirement for this reason.

(b) *Microphonics.*—This condition was alleged to be the result of faulty tubes in 3-2000-cps. amplifiers. Since the microphonic frequencies were around 300 cps., these disturbances if present would be reduced by the galvanometer charactertics of the present carrier equipment.

(c) *Hash caused by beat frequencies of different oscillators in the same set of equipment.*—In the one case encountered the hash was eliminated by raising the beat frequency to 400 cps. The path involved in the channel interaction is not definitely known but was present in a strain gage installation.

If the equipment now on order proves to be relatively trouble free, it should satisfy most of the requirements for dynamic test equipment for aircraft. The requirements not only call for accuracy within 5% but specify the following sizes and weights:

(a) 200 in.^{3} and 8 lbs. per channel for the carrier equipment excluding the oscillographs.

(b) 50 in.^{3} and 2 lbs. per channel for the d-c. bridges.

(c) Size and weight of the 34-channel oscillographs to be about the same as the present 12-channel oscillograph (3000 in.^{3} and 70 lbs.)

One further possibility for a reduction in size, which is now being investigated, lies in the development of high-output electromagnetic accelerometers and pressure gages which will directly operate oscillographs through the phase-discriminating detector which has been mentioned previously. To reduce the size of the complete equipment installation, some thought has also been given to the possibility of obviating the need for storage batteries, which have been a nuisance. The carrier equipment will thus receive power from standard 115-v. 400-cps. aircraft inverters which have been found satisfactory for the purpose. Unfortunately, no suitable battery substitute has been found for operating the strain-gage bridges and oscillographs. However, the possibility of a voltage regulator operating from a 24-volt aircraft system is now being considered as an oscillograph power source.

Future developments in dynamic test equipment will center around telemetering for obtaining data for pilotless aircraft and projectiles. Smaller pick-ups (perhaps ½″ diameter by ¼″ high) such as accelerometers and aerodynamic pressure gages will also be required to fit the thin wings which are on the way. Accelerometers approaching this size have already been developed for flutter model tests. Since telemetering systems will probably employ much standard dynamic test equipment and considerable dynamic testing of piloted aircraft is still essential, the equipment described in this article will not be obsolete for some time to come.

A Low-speed Tachometer

By EDWARD C. BLOM, Physics Department, Cornell Aeronautical Laboratory, Buffalo 5, N. Y.

AN electrical indication of the speed of a slowly-rotating shaft may be desired when little power from the shaft is available. At speeds between 1 to 600 rpm, the voltage generated by a conventional tachometer generator is inconveniently low. If gears are used to increase the speed of the tachometer shaft, the power required to drive the tachometer becomes excessive. Another difficulty encountered with brush type generators running at low speeds is caused by a film that develops on the commutator or slip rings after a few hours of running time, and wide fluctuations of the voltmeter reading for the same shaft speed result. These disadvantages are avoided by using a two-phase drag-cup type a-c. motor as the tachometer.

Normally, drag-cup motors are driven by applying two voltages whose relative phase differs by 90 degrees. However, when used as a generator, with an a-c. voltage applied across one of the two windings, the induced a-c. voltage developed across the other winding will be proportional to the speed of the shaft for low speeds. The induced voltage is then amplified to the level desired; since the tachometer output is a.c., a simple, rugged a-c. amplifier is ample for this purpose. After amplification the signal may be made to operate relays, or to move a recording pen as desired.

In Fig. 1, it is seen that winding 2 is connected directly across the source of power, while winding 1 is connected in series with a voltage-dividing network across winding 2. As the shaft of motor M turns, a voltage is induced in winding 1 by winding 2. When an indication of the direction of rotation is not desired, R_2 is set to zero so that no polarizing voltage is present. Fig. 2 shows a typical calibration curve of the tachometer under these conditions. If rotational direction is meaningful, R_2 should be increased to the desired level; now, turning motor M in one direction increases the total output signal while turning in the opposite direction decreases this signal.

When the polarizing voltage has been set to 1.0 volt, there results the curve shown in Fig. 3, which registers both speed and direction. The deviation from linearity of the curve is caused by difference in phase angle between the polarizing voltage and the induced voltage.

The choice of power-supply voltage is determined by the maximum amount of dynamic braking that the mechanical system can tolerate. Decreasing the supply voltage reduces the amount of braking, but in so doing increases the tachometer sensitivity to external electrical disturbances. Fifty volts was found to be a good compromise. Under these conditions the torque required to rotate the shaft is 0.0005 ounce-inches.

Since the level of output signal depends directly upon the value of the power supply voltage, accuracy greater than the limits of power supply regulation should not be expected.

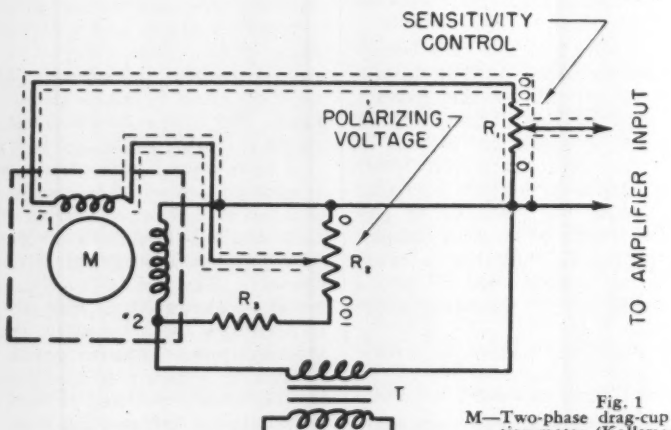

Fig. 1
M—Two-phase drag-cup type induction motor (Kollsman Type 799-05)
R_1—1.0 megohm volume control
R_2—500-ohm volume control
R_3—20000-ohm 0.5-watt resistor
T—115-volt to 50-volt transformer

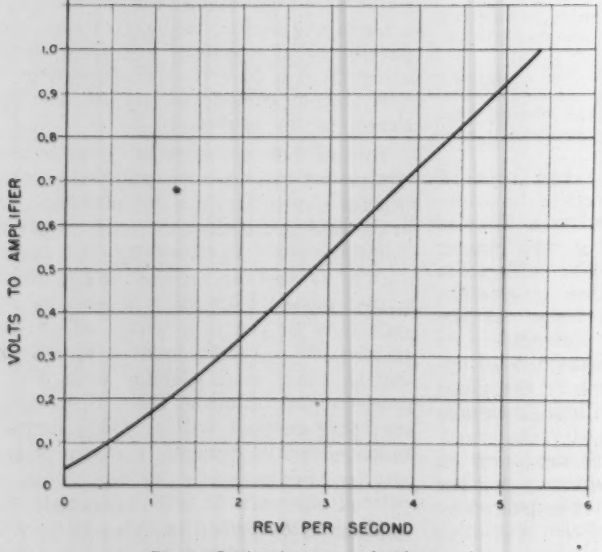

Fig. 2. Calibration curve $d\phi/dt$ recorder.

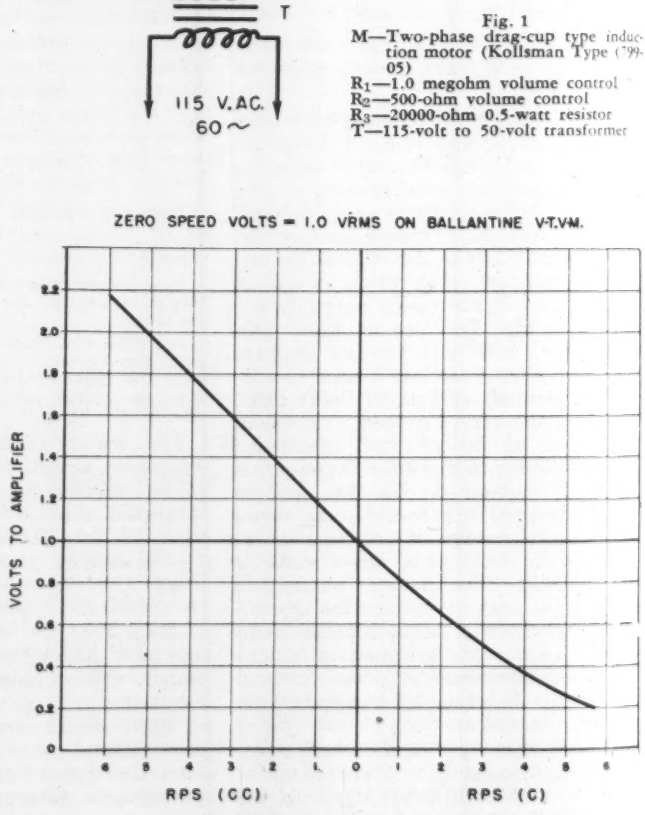

Fig. 3. Calibration curve $d\phi/dt$ recorder.

Sound and Vibration Measurements*

By H. A. LEEDY, Armour Research Foundation, Chicago

Introduction

THE subject of the control of sound and vibration is of extreme importance to industry today. Unwanted sound or excessive vibration is generally associated with poor workmanship or poor mechanical design. Excessive office or factory noise often results in lowered efficiency. The consumer is becoming increasingly conscious of noise and vibration, and is more critical about these disturbances than ever before. It behooves all of us to learn more about methods of controlling these undesirable and frequently unnecessary disturbances.

In the control and reduction of these undesirable sounds and vibrations, one of the first steps is to be able to measure them. However, before discussing measurements, it is important to know more about what we want to measure.

Since sound, in the physical sense, is a vibratory motion, the measurement of vibrations includes the measurement of sound. The dictionary defines sound as those vibrations which affect the sense of hearing. However, just as it is becoming customary to regard light as including invisible radiation in the infrared and ultraviolet, so it has become common practice to include as sound those vibrations which are inaudible—infrasonic and ultrasonic. For example, during the war a large research program was carried on in a field called "Underwater Sound," although most of this work was in the ultrasonic region outside the range of hearing.

However, for purposes of the discussion which follows, we will use the more limited definition of sound and include only those frequencies in the audio range, namely 20 to 20,000 cps. Later, in discussing vibration measurements, we will confine our attention to those vibrations most troublesome in industrial machinery. These mechanical vibrations are of low frequency, ranging from a few cycles to a few hundred cycles per second.

Sound Measurements

In any discussion of sound measurements it must be clearly understood that there are two aspects to the word "sound": (1) the subjective or psychological aspect and (2) the objective or physical aspect. Subjectively, sound is the sense impression of the organ of hearing; objectively, it is the actual vibratory motion which produces this sensation.

In all sound measurements it must be borne in mind that it is the physical properties which are measured, not the sensation properties. The physical properties of principal interest, are: (1) the intensity, measured in watts per square centimeter per second, or the corresponding logarithmic unit, intensity level, measured in decibels, and (2) the frequency, measured in cycles per second. In a complex sound consisting of many frequencies, it is necessary to measure the intensity level at each frequency or, in other words, to determine the frequency spectrum.

All of us are familiar in a qualitative way with the subjective characteristics of sound. There are three principal characteristics which we can readily distinguish: loudness, pitch and quality. It is the ultimate goal of practically all sound measurements to be able to interpret physical measurements in the terms of the subjective sensation which the ear perceives. Casual observation would indicate that this interpretation is quite simple, the pitch being determined only by frequency, and loudness only by intensity level. However, careful measurements have shown that the relationship between the subjective properties and the physical properties is very complex. Such measurements have shown that although pitch is primarily determined by frequency, it is also dependent to some extent upon intensity level. This variation of pitch with intensity level can readily be observed by suddenly changing the volume control on an oscillator tone.

The dependence of loudness upon frequency and intensity level is much more complex. This relationship can best be shown graphically as illustrated in Fig. 1. In this graph, the curved lines are contours of equal loudness. It is observed that at the low and high frequencies the intensity level must be considerably greater than in the mid-frequency range to produce the same sensation of loudness. For example, a thousand-cycle note having an intensity level of 20 decibels is as loud as a 50-cycle note having the considerably higher intensity level of 63 db.

With the above information as a background, we are now in a better position to discuss the measurement of the physical properties of sound and their relationship to our subjective sensations. The measurement of the physical properties of sound, even under the best conditions, is a difficult problem. It has been stated by Morse: "In no other branch of physics are the fundamental measurements so hard to perform and the theory relatively so simple; and in few other branches are the experimental methods so dependent

*Presented at the first Annual Conference of the Instrument Society of America, William Penn Hotel, Pittsburgh, Penna., Sept. 16-20, 1946.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.

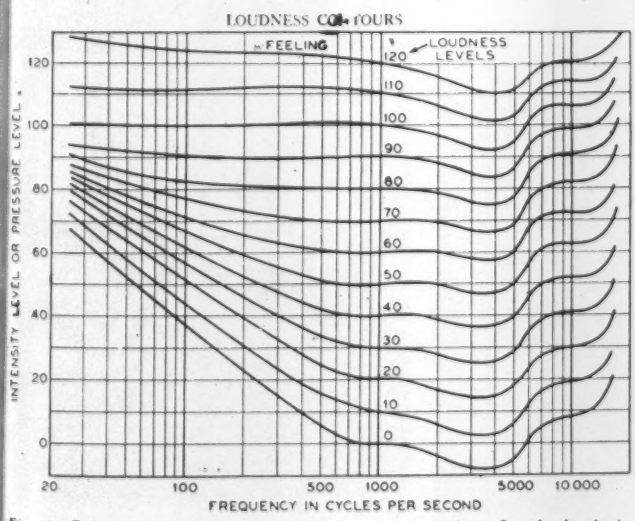

Fig. 1. Relative sensitivity of normal human ear (Am. Standards Ass'n results) to low-, medium- and high-pitched pure tones.

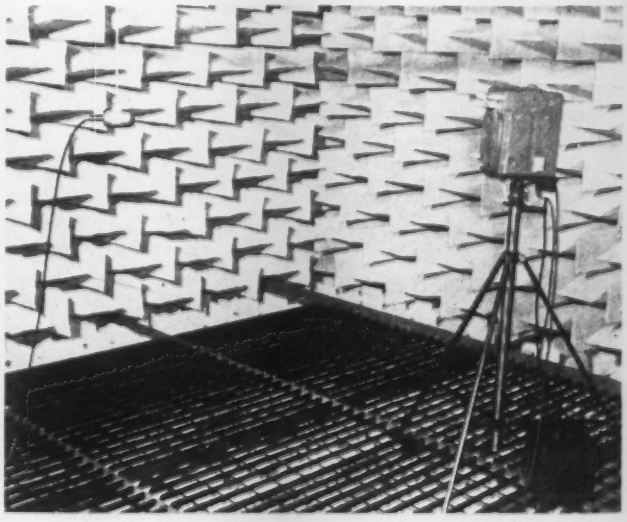

Fig. 2. Free Field Room for Sound Measurements.

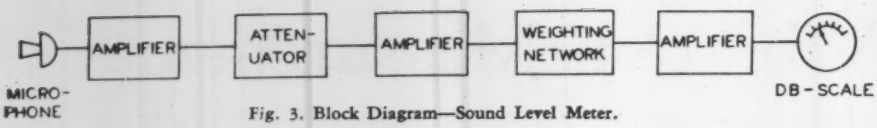

Fig. 3. Block Diagram—Sound Level Meter.

upon a thorough knowledge of the theory."

One of the reasons for this difficulty is the infinitesimal magnitude of the energy in a sound wave. If, for example, all of the people in the city of Pittsburgh were to begin talking in a normal conversational tone, and if it were possible to collect the entire sound output of this large group and convert it without loss into electric energy, there would barely be enough power to light a 10-watt electric lamp. Obviously, the sensitivity of acoustical instruments must be very high.

The large intensity ranges encountered in sound measurements present still another difficulty. Intensities differing by a factor of 10^{13} (ten billion billion) can be detected by the ear and it is desirable to design sound instruments capable of measuring this extremely wide range.

Fig. 4. Sound Level Meter.

	DECIBELS	THRESHOLD OF FEELING	INTENSITY UNITS	SOUND PRESSURE DYNES/SQ.CM.
VERY LOUD DEAFENING	120	THUNDER, ARTILLERY	1,000,000,000,000	200.
	110	NEARBY RIVETER ELEVATED TRAIN	100,000,000,000	
	100	BOILER FACTORY LOUD STREET NOISE	10,000,000,000	20.
	90	NOISY FACTORY TRUCK UNMUFFLED	1,000,000,000	
LOUD	80	POLICE WHISTLE NOISY OFFICE	100,000,000	2.
	70	AVERAGE STREET NOISE AVERAGE RADIO	10,000,000	
MODERATE	60	AVERAGE FACTORY NOISY HOME	1,000,000	0.2
	50	AVERAGE OFFICE AVERAGE CONVERSATION	100,000	
FAINT	40	QUIET RADIO QUIET HOME OR	10,000	0.02
	30	PRIVATE OFFICE AVERAGE AUDITORIUM	1,000	
VERY FAINT	20	QUIET CONVERSATION RUSTLE OF LEAVES	100	0.002
	10	WHISPER SOUND PROOF ROOM	10	
	0	THRESHOLD OF AUDIBILITY	1	0.0002

Fig. 5. Summary of Sound Measurements for Some More Common Sounds.

Perhaps one of the greatest difficulties encountered in sound measurements is the interference resulting from reflection and refraction. If one attempts to measure the output of a loudspeaker in an ordinary room, he will experience no end of difficulty because of the standing wave pattern resulting from reflections from the walls. Under such conditions the intensity measured at a point at some distance from the loudspeaker may be several times greater than the intensity measured at some point nearer the loudspeaker. One method of avoiding such reflections is to make such measurements outdoors. Difficulties still persist here because of refraction of sound due to wind or temperature gradients.

In order to avoid these difficulties, special rooms have been designed with highly absorbent walls to minimize effects of reflection. A photograph of such a room is shown in Fig. 2. In this room the walls are covered with wedges of glass wool with the result that less than 0.01% of the incident sound energy is reflected. Such a room approximates the outdoors without having the disadvantages of inclement weather, wind and temperature gradients.

Because of these difficulties, especially that of the minute energy contained in a sound wave, early experimenters had an almost impossible task

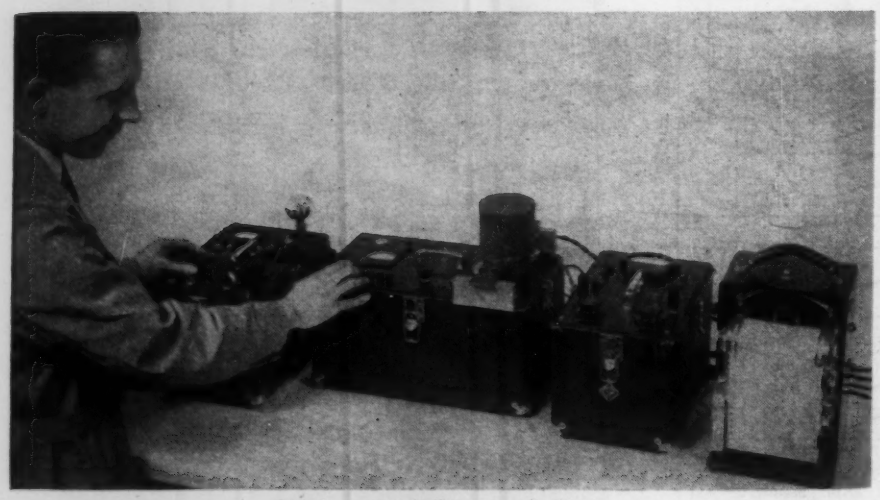

Fig. 6. Automatic Frequency Analyzer.

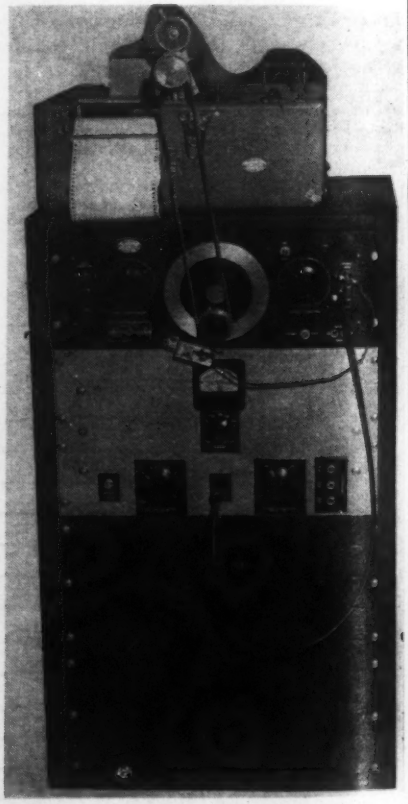

Fig. 7. Apparatus for Automatic Measurement of Frequency Response.

in trying to measure sound intensities. A very ingenious method of measuring sound intensity was devised by Lord Raleigh. It consisted of a thin disk suspended by a quartz filament. Sound waves incident on this disk caused it to rotate; from the angle of rotation the intensity could be calculated. The Raleigh disk has relatively poor sensitivity and is difficult to use. However, it is one of the few instruments whose calibration is absolute and even today it is used for the calibration of "standard" microphones.

However, in spite of the ingenuity of early experimenters, there was little progress in the measurement of sound until the vacuum tube came to the rescue. With the development of high-gain electronic amplifiers, the science of sound measurement grew by leaps and bounds. This resulted in a renewed interest in the subject of sound and its measurement. Practically all sound measuring instruments today are, in part, electronic.

One of the most widely used instruments for sound measurement is the so-called sound level meter. In this instrument an attempt is made to adjust the frequency response so that the reading corresponds to loudness level rather than intensity level. The information contained in Fig. 1 is of considerable value in the design of such instruments. In present-day sound level meters, the frequency response of the electronic amplifier is altered by "weighting networks" (filters) so that the response approximates that of the ear. It is evident from Fig. 1 that in order to accomplish this exactly, the weighting network must change continuously as the intensity changes. Actually, in present commercial instruments only three different weighting networks are used, each one being a compromise for a specified range of intensities.

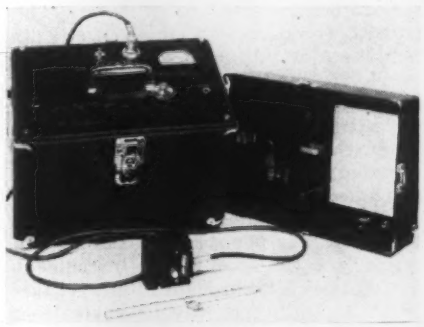

Fig. 10. Vibration Meter.

A block diagram of such a sound level meter is shown in Fig. 3. In addition to the weighting network, an attenuator is inserted in the circuit in order to be able to accommodate the wide range of intensities. It is evident that before the advent of electronic amplifiers, the development of such an instrument would have been practically impossible.

In Fig. 4 is shown a commercial model of a widely-used sound level meter. This instrument is capable of measuring intensity levels from 25 to 130 db and has three weighting networks; one for low-intensity sounds, a second for moderate-intensity sounds, and a third for high-intensity sounds. This meter is operable from either a battery for portable field use or from a power pack for laboratory use. With instruments of this general type the intensity levels of many different sound sources have been measured. A summary of such measurements for some of the more common sounds is given in Fig. 5.

The sound level meter gives an indication of the overall intensity level of both pure tones and complex sounds. For pure tones (sine waves) the only additional information required is the frequency. However, for complex sounds, as has been indicated earlier, it is desirable to know the intensity level at all frequencies, i.e. the frequency spectrum.

In Fig. 6 is shown a set of equipment suitable for obtaining automatically the frequency spectrum of a given sound. This equipment consists of a sound level meter, a motor-driven frequency analyzer, a logarithmic amplifier, and a pen and ink recorder. With such equipment it is possible to obtain a graph in which the intensity level in decibels is plotted against frequency. The principal advantage of such equipment is that the frequency spectrum can be obtained much more rapidly than by other methods in which similar information has to be obtained by plotting the curve point by point.

A common type of sound measurement is the determination of the frequency response of microphones, loudspeakers and sound-recording and -reproducing equipment. In Fig. 7 is shown a set of instruments for making such response measurements automatically. It consists of an oscillator for producing a tone of any frequency in the audio range plus an intensity level recorder which is coupled to the oscillator. With such equipment, frequency response curves on most types of acoustical equipment can be made rapidly.

The acoustical properties of rooms, auditoriums, radio studios, etc., are best determined by measurement of the rate at which sound decays in the enclosure. This rate of decay is often quite rapid and it is necessary to have intensity level equipment suitable for measuring this rapid rate of decay. A suitable instrument for this purpose, called a high-speed level recorder, is shown in Fig. 8. It is capable of following changes in intensity level as rapid as 300 db/sec.

In sound measurements it often occurs that the sound we wish to analyze is of relatively short duration and may occur only once. Such sounds can be analyzed by first making a recording of the sound which can then be played over and over again for detailed study

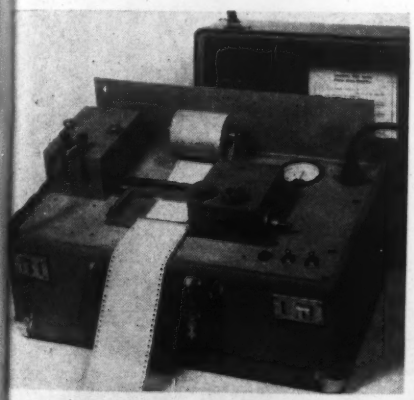

Fig. 8. High Speed Level Recorder.

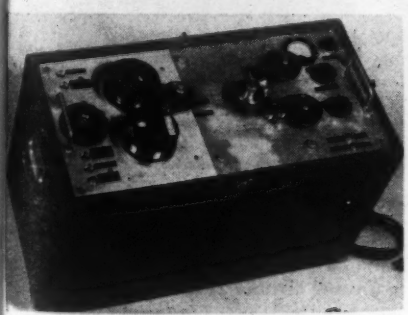

Fig. 9. Magnetic Wire Recorder.

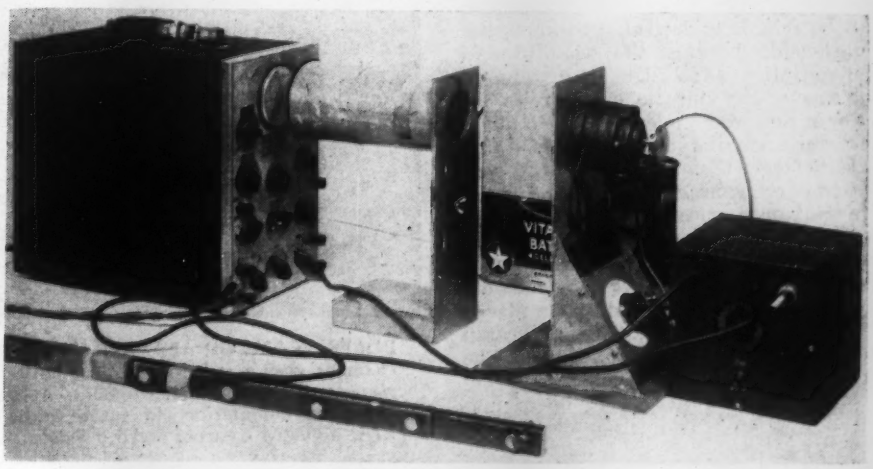

Fig. 11. Transient Vibration Recorder.

and analysis. The Armour Research Foundation has developed a magnetic wire recorder which has proved very useful for such studies. This recorder is shown in Fig. 9. Its frequency response is flat within ± 1.5 db from 30 to 15,000 cps. and it is capable of making continuous recordings over a half-hour period.

This recorder has also proved very valuable as an "acoustical notebook." For example, in noise-reduction research on industrial machinery, it is often desirable to make sound recordings of the noise with each change in design. Such recordings can then be played back later, when the loudness as well as the quality of the noise from the several designs can be compared.

Vibration Measurements

Although the lower limit of hearing for average individuals is about 20 cps., frequencies lower than this can cause considerable annoyance. Such vibrations can be felt rather than heard. This ability to feel vibrations through the sense of touch extends well up into the audible range. Instruments to measure such vibrations must necessarily have a lower frequency response than sound measuring instruments.

In vibration measurements several magnitudes can be measured: (1) frequency, (2) displacement, (3) velocity and (4) acceleration. As in sound, the magnitudes which one chooses to measure depend upon the information required for the particular problem.

For example, a determination of the frequency of a given vibration often points to the source of the vibration, such as an unbalanced wheel or gear rotating at the same frequency. Also, in the design of vibration isolation supports, a knowledge of the frequency of the vibration to be isolated is required. In rotating or reciprocating machinery, vibrations often produce stresses which, if excessive, will result in the failure of the vibrating member. In this case, the amplitude of the vibration is measured in order that these stresses may be calculated. Vibration acceleration measurements are often made in automobiles and other vehicles to determine the magnitude of the bumps or jerks which the passengers experience.

Since many mechanical vibrations can be felt, it is desirable to know the relationship between the stimulus and the sensation effect. Unfortunately, in the case of the vibrations, this relationship is not well understood and much research remains to be done in this field before we can determine the sensation effect from a measurement of the physical properties of vibration.

Early instruments for measuring vibration amplitude were generally of the "seismic" type. These instruments were large and bulky and, when placed in contact with the vibrating part, often materially alter the amplitude of the vibration. Here again, electronic developments have proved to be of material aid by providing smaller, more sensitive instruments.

A very useful electronic vibration instrument is shown in Fig. 10. It consists of a piezoelectric vibration pick-up, an electronic amplifier and a calibrated output meter. The pick-up consists of a small square crystal rigidly mounted at three corners, the fourth corner being free to vibrate. The natural frequency of this crystal is such that for vibration frequencies below 1,000 cps. the voltage output of this pick-up is proportional to the vibration acceleration. By suitable electrical integrating networks, it is possible also to measure velocity and amplitude. This instrument indicates acceleration in inches per second per second, velocity in microinches per second or amplitude in microinches. Thus in one instrument is contained a "vibrometer," a "velocitometer" and an "accelerometer"—a combination impossible with previous mechanical types of instruments.

For many types of vibration measurements in which large accelerations are involved, the crystal pick-up is too fragile. In this case, a resistance pick-up (often called a strain gage) or a dynamic pick-up is preferable.

A vibration engineer is often required to measure the wave-form of transient vibrations. In this case the indicating instrument must have a very rapid response, such as one can obtain with a string oscillograph or a cathode-ray oscillograph. In Fig. 11 is shown a set of equipment suitable for the measurement of transient vibrations. In this particular equipment the output from a resistance type pick-up is amplified and then sent to the deflecting plates of a cathode-ray tube. The motion of the light spot on the cathode-ray screen is photographed by a special camera containing a continuously-moving film. In this way a permanent record of the wave-form of the transient vibration is obtained.

Many other types of vibration-measuring instruments are available for use to the vibration engineer. Although there is no universal instrument for measuring all types of vibrations, a good engineer thoroughly familiar with the theory of vibrations can usually find a suitable instrument to meet his special needs.

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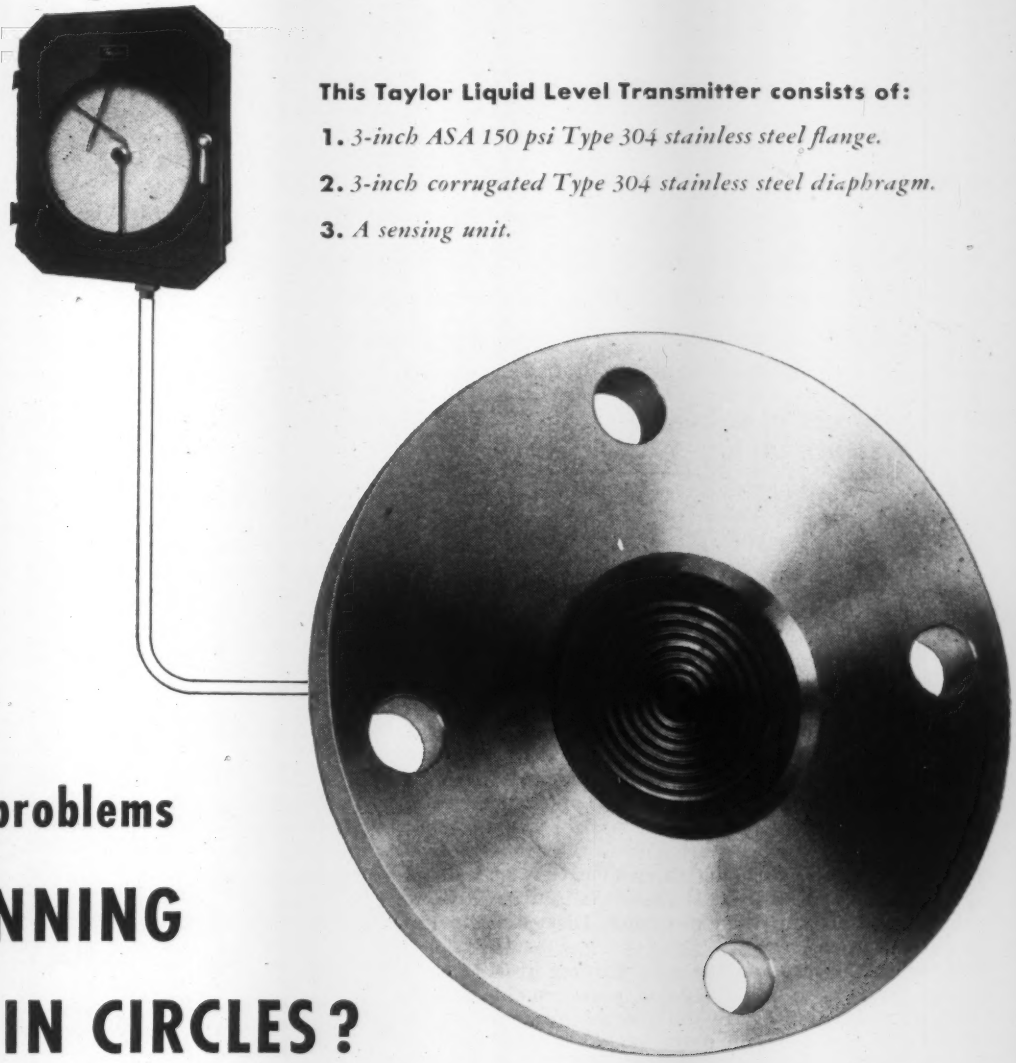

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IN HOME AND INDUSTRY

Scientific Glass Blowing and Laboratory Techniques

By WILLIAM E. BARR and VICTOR J. ANHORN, Gulf Research & Development Company

XII. GAS ADSORPTION APPARATUS FOR MEASURING SURFACE AREAS

[This article was prepared in collaboration with Dr. Leslie G. Joyner, Mellon Institute of Industrial Research]

In recent years the study of the adsorption of gases on solids has received considerable attention from both the theoretical and applied scientist. This is due in a great part to the excellent work of Brunauer, Emmett and Teller[1]. They showed how the total area of a porous or finely divided powder could be calculated from gas adsorption data. Because of the increasing importance of this type of work, this article will be devoted to a description of the most general form of gas adsorption apparatus. Details of the operation and method of obtaining the surface area will be included.

The surface area of a solid is of extreme importance in many chemical processes where gas or liquid reactions occur either on the surface or under the influence of the surface of solids. Contact catalytic reactions, such as take place in the cracking of hydrocarbons, the hydrogenation of vegetable oils and adsorption refining processes such as occur in clay treating of gasolines and in sugar refining are a few cases where surface area is important. Since most of the solids which are used as catalysts or adsorbents in this type of work are of a porous nature an adequate measure of the surface area must include the area involved in the walls of the pores (the internal area) as well as the external area. Indeed in most cases the internal area is many times greater than the external and is generally the more important of the two.

The problem in measuring the total surface area of such porous substances is to find a unit of measurement of area small enough to be used in the sub-microscopic pores which may be only a few angstrom units in diameter. The molecules of a gas such as nitrogen prove to be a suitable yardstick and have the advantage that we know or can estimate their size with a reasonable degree of accuracy. If one could completely cover the surface of a solid including the internal area with a single layer of gas molecules (e.g. nitrogen) and then count the number of molecules it took to do so it would be possible to determine the total area since the area covered by a single molecule can be determined from known physical constants of the gas. This is essentially the procedure developed by Brunauer, Emmett and Teller[1] who will hereafter be referred to as BET. They showed how to count the number of molecules of a gas corresponding to a single layer covering the entire surface of a solid.

When a solid is exposed to a gas a definite amount of the gas will adhere to or be adsorbed on the surface of the solid if the temperature is in the neighborhood of the normal boiling point of the gas. This adsorption is due to forces similar to those which are involved in the condensation from the gaseous to the liquid state. The volume of gas which will be adsorbed on any given surface depends upon both the temperature and the pressure of the gas. As the temperature is increased, the amount of gas adsorbed decreases. On the other hand the effect of an increase in pressure is to increase the adsorption. In the determination of the area the temperature is kept constant and the amount of gas adsorbed is measured as the pressure is altered. A plot of such data is called an adsorption isotherm. Although the study of adsorption phenomena in general is extremely important, for the purpose of this article we will consider only the adsorption of nitrogen at temperatures close to its normal boiling point (—195.8°C.) since this is the gas most generally used for area measurement. A typical nitrogen isotherm is shown in Fig. 155.

Adsorption isotherms have been classified into five general types but the "S" shaped isotherm shown in Fig. 155 is by far the most common type and the one to which the BET theory in its simplest form applies. (For a more detailed study of the types of isotherms one may consult "The Adsorption of Gases and Vapors, Vol. I, Chapter VI by S. Brunauer). Although many attempts to explain adsorption phenomena have been made, it was not until BET developed the so-called "multilayer theory" that a satisfactory explanation of all five types of adsorption isotherms was possible. The basic assumption of the BET theory is that several layers of gas can be adsorbed on a solid surface. The BET theory results in the following expression for the isotherm of a gas adsorbed on a free surface.

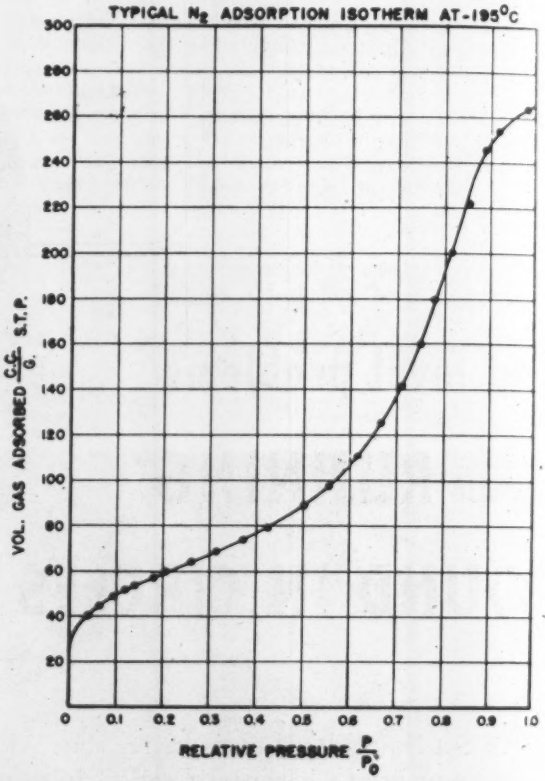


Fig. 155

$$V = \frac{V_m\, cP}{(P_0 - P)\ (1+(c-1)\ P/P_0)} \qquad (28)$$

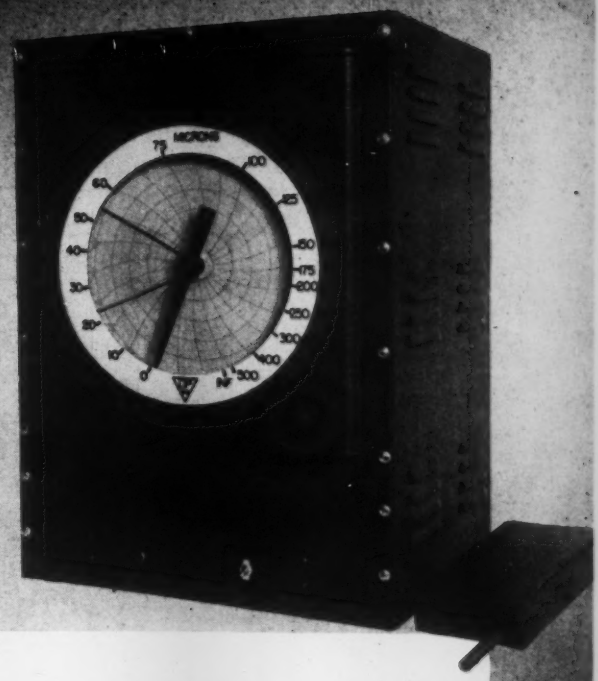
where V is the volume of gas at 0°C. and 1 atmosphere pressure, P is the pressure, P_0 is the vapor pressure of the gas at the temperature of the adsorbent, c is a constant related to the heat of adsorption and V_m is the volume of gas (s.t.p.) necessary to form a single layer over the entire surface. It is the determination of the constant V_m which makes possible the measurement of the total area.

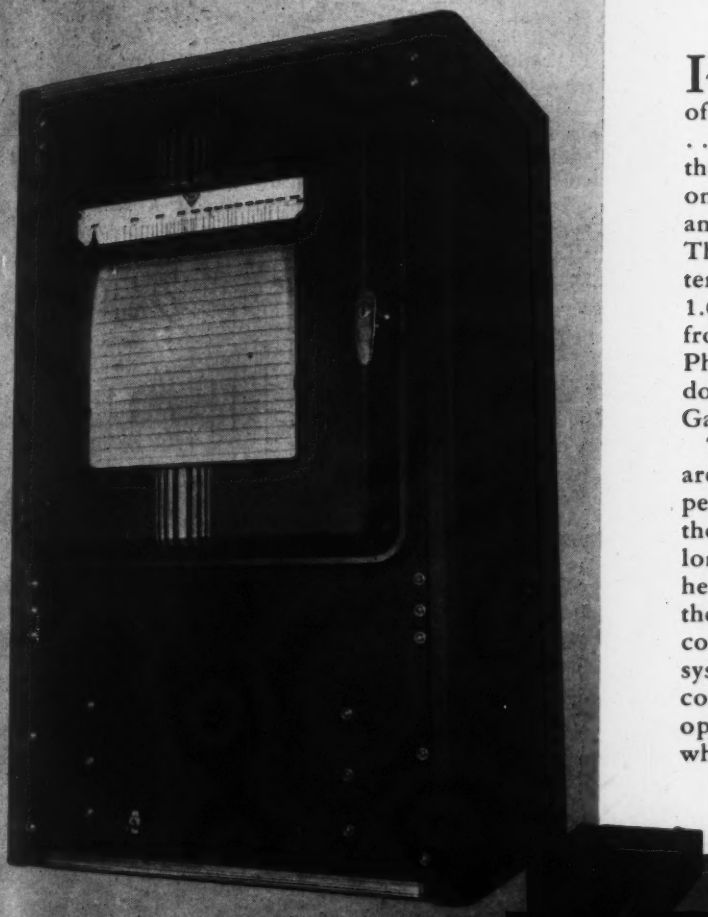
Although equation (28) was derived for a flat surface it is still applicable over a limited range to porous materials which have typical "C" shaped isotherms. For certain extreme types of "S" shaped isotherms a more complicated form of equation (28) becomes necessary[2].

Of the various quantities in equation (28) P, P_0 and V

HIGH-VACUUM RECORDS

At a glance





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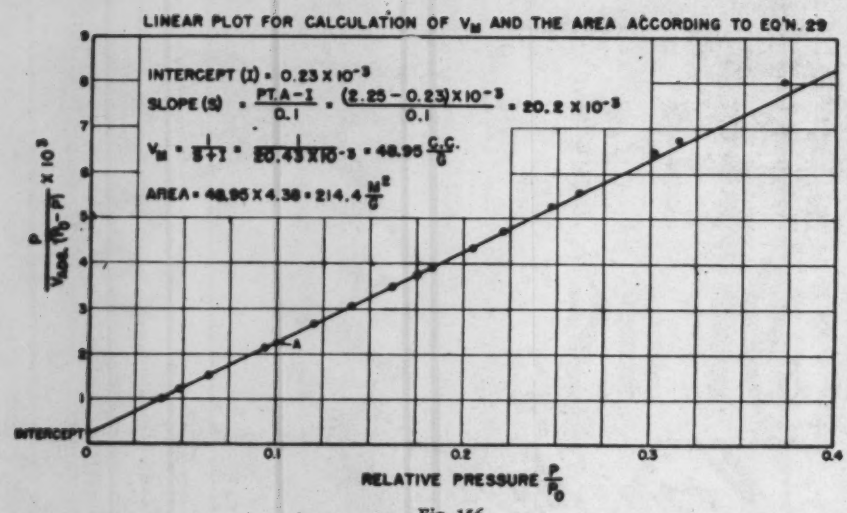
LINEAR PLOT FOR CALCULATION OF V_M AND THE AREA ACCORDING TO EQ'N. 29
INTERCEPT (I) = 0.23 X 10⁻³
SLOPE (s) = PT. A−I / 0.1 = (2.25 − 0.23) X 10⁻³ / 0.1 = 20.2 X 10⁻³
V_M = 1/(s+I) = 1/20.43 X 10⁻³ = 48.95 cc.c.
AREA = 48.95 X 4.36 = 214.4 M²/G
INTERCEPT
RELATIVE PRESSURE P/P₀

Fig. 156

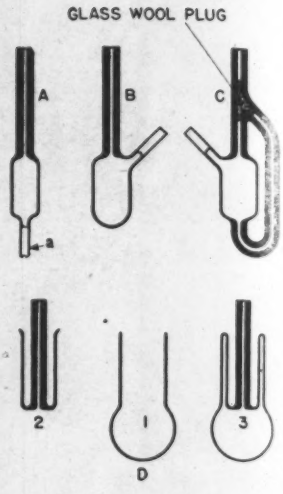

Fig. 158

are determined experimentally and V_m and c can be obtained by putting equation (28) into linear form

$$\frac{P}{V(P_0-P)} = \frac{1}{V_m c} + \frac{c-1}{V_m c} P/P_0 \qquad (29)$$

and plotting $P/[V(P_0-P)]$ vs P/P_0. If equation (28) is valid such a plot should give a straight line with

$$\text{slope } (s) = \frac{c-1}{V_m c} \text{ and intercept (I)} = \frac{1}{V_m c} \qquad (30)$$

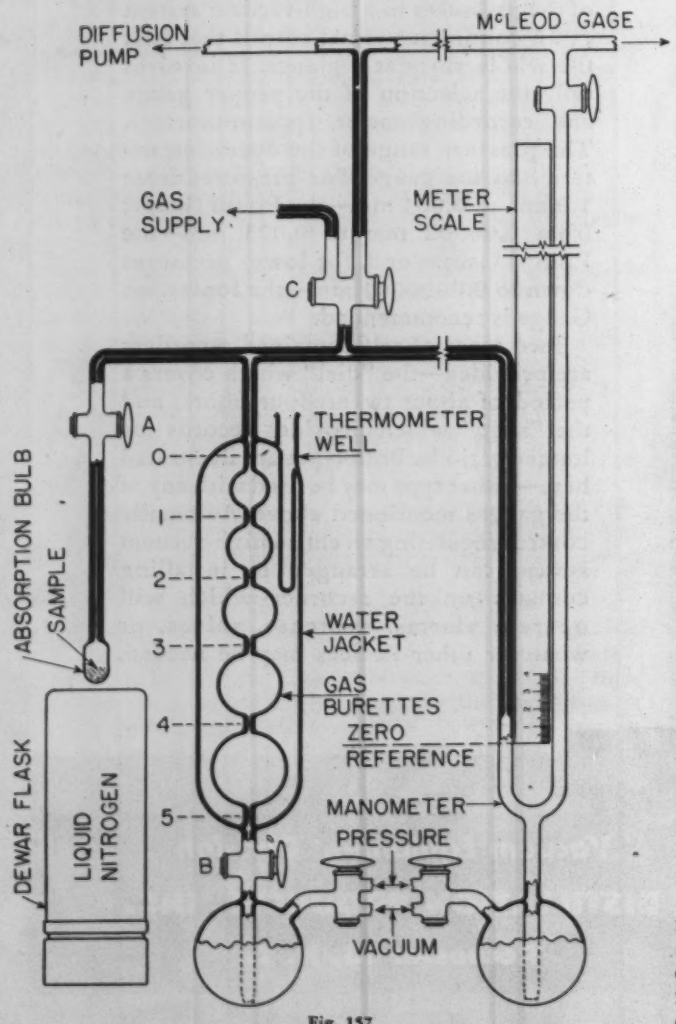

Fig. 157

For most isotherms a straight line is obtained for only the lower portion of the isotherm up to a relative pressure (P/P_0) of about 0.3. This straight line, however, is sufficient to determine the constants V_m and c from its slope and intercept. From equations (30) it is easy to show that

$$V_m = \frac{1}{s+I} \text{ and } c = \frac{s}{I} + 1 \qquad (31)$$

Fig. 156 shows the isotherm of Fig. 155 plotted according to equation (29).

Since V_m is the volume of gas at 0°C. and one atmosphere necessary to cover the surface with one layer of gas it is a simple matter to convert it to the number of molecules involved. A detailed discussion of the various assumptions involved in the determination of the area covered by each molecule is not in place here. Such a discussion is given by BET[1]. The end result shows that the total surface area is related to V_m as follows:

$$\text{Area (sq. meters)} = 4.38\ V_m \text{ (cc.s.t.p.)} \qquad (32)$$

Description of the Apparatus

Having developed a brief outline of the theory it is now necessary to consider an apparatus which will give the experimental data necessary to determine the surface area of a porous or finely divided solid. The type of apparatus discussed here is not the only kind which will give suitable data but it is one of the most common types. The essential parts of the apparatus and its manipulation will be described first. In addition it will be helpful to describe some auxiliary apparatus that may be incorporated into the system in order either to increase the precision and accuracy of the data or to increase the ease of manipulation.

First, however, it will be helpful to consider what is expected of the apparatus. In order to determine the area utilizing the BET theory, we must have the data necessary to make a plot similar to Fig. 156 in which $P/[V(P_0-P)]$ is plotted against P/P_0. Consequently the quantities needed to determine a particular point are P the pressure, V the volume of gas adsorbed at the pressure P, and P_0 the vapor pressure of the gas at the temperature at which the adsorption is being determined. Since several points are required the apparatus should be capable of altering the pressure so that a series of points can be determined without too much difficulty. Inasmuch as P_0 will depend solely upon the temperature of the low temperature bath, it can be determined independently of the actual adsorption data, i.e. P and V.

The common form of low-temperature adsorption apparatus shown in Fig. 157 meets all the requirements outlined above. The volumes of the various bulbs in the burette are determined before the apparatus is assembled. The remaining volume of the system between the zero of the manometer and the stopcock A is calibrated as will be described

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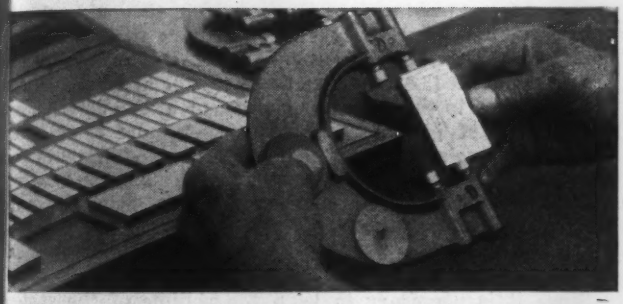

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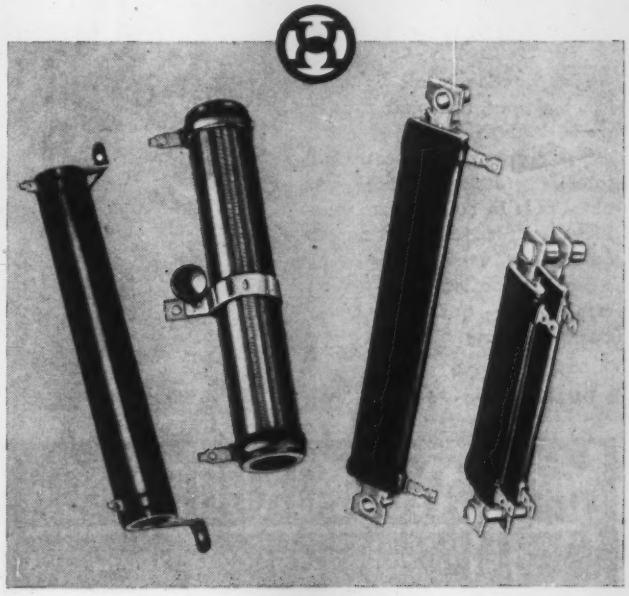

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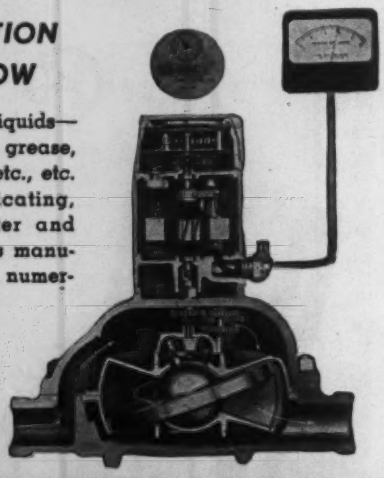

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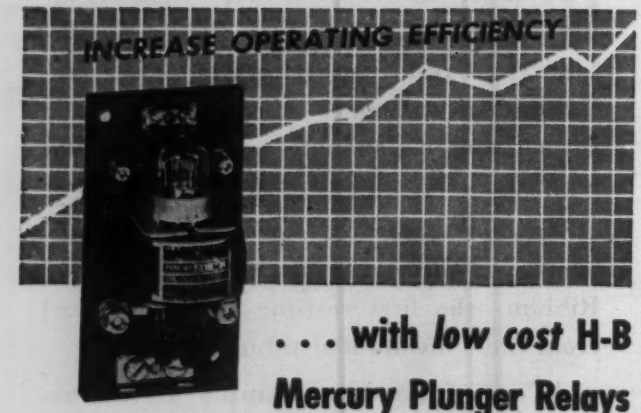

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later. The volume of the free space in the adsorption bulb is determined by calibration with helium at the temperature of liquid nitrogen. Helium is used because its adsorption at liquid nitrogen temperature is effectively zero on nearly all solids. Once the volume of all parts of the apparatus is known and the system evacuated, a sample of nitrogen can be admitted to the burette with stopcock *A* closed. By determining the pressure and the temperature of the burette this volume can be converted to standard conditions. With the liquid nitrogen bath surrounding the adsorption bulb, stopcock *A* is then opened. After allowing sufficient time for equilibrium to be established, the pressure is again determined. This, together with the known volume of the system up to stopcock *A*, allows the determination of the volume of gas remaining in the burette. The calibration of the adsorption bulb permits one to calculate the amount of gas in the adsorption bulb. Thus the volume of gas adsorbed is the original volume taken minus the amount remaining in the burette and the amount in the adsorption bulb. By allowing the mercury to fill the various bulbs of the burette the volume of the system can be altered by known amounts and hence several points can be taken in succession without any difficulty.

As indicated in Fig. 157, some auxiliary apparatus is required such as the high vacuum system, gas reservoirs, etc. Since vacuum pumps and gages have previously been discussed, they will not be mentioned except to point out that they are needed. The details on the rest of the system will now be discussed.

Gas Reservoirs

Two gas reservoirs of 2- to 5-liter capacity are required, one for the helium to be used in the calibrations and one for the adsorbate which we will assume to be nitrogen. They should be attached to the system in such a way that they can be completely evacuated before being filled with the gas. It is good practice to keep the pressure in the reservoirs always above atmospheric so that there will be no danger of air leaking into the reservoir through a faulty stopcock. Care must be taken not to have the pressure so high that the stopcocks are blown loose. Pressure stopcocks are recommended. An open end manometer at least 76.0 cm. long attached to the reservoir is convenient for determining the amount of gas in the reservoir. A more complicated type of reservoir but one which has certain advantages and can be used for storing gas at subatmospheric pressures will be described later in connection with a more elaborate apparatus.

Manometer

Since it is necessary to keep the volume of the system constant, the mercury in the pressure leg of the manometer is always adjusted to a reference point corresponding to the zero point of the scale. The manometer should be made of 10-mm. tubing so as to minimize meniscus effects of the mercury. In order to avoid capillary effects the manometer at the reference point must have the same diameter as the opposite leg. The reference point should, however, be as close to the capillary tubing as possible and still have the proper diameter, otherwise the free space of the system will be needlessly increased. The manometer should also extend for several inches below the reference point so as to avoid the danger of the mercury being accidentally forced around the "U" bent during a rapid increase in pressure.

Burette

The burette, Fig. 157, consists of a series of bulbs of various sizes connected by short lengths of capillary tubing. Some type of reference mark is made on each capillary tube and also below the bottom bulb and above the top bulb. In this way each bulb has a reference mark above and below it and the volume between the marks for each bulb must be accurately known. These volumes are determined by calibrating with water or mercury before the burette is attached to the system. In order to calibrate the burette the stopcock *B* should be attached. By means of a vacuum pump

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attached to the upper capillary, mercury may be drawn up into the burette filling all the bulbs up to the top reference point. The flow of mercury is, of course, controlled by the stopcock. The temperature of the burette is then taken. A tared beaker is placed under the stopcock which is then opened until the mercury drops to the second reference mark. The volume of mercury collected in the beaker will correspond to the volume of the top bulb. The mercury collected is then weighed and from the density of mercury at the temperature of measurement, the volume of the bulb corrected to 0°C. will then be

$$\text{Vol. (cc.)} = \text{weight (gm)}/d \text{ (gm/cc.)}.$$

Since most of the gas volume in the system is in the burette bulbs, it is important that the burette be thermostated. This may be accomplished simply by a water jacket with an air jet for agitation or liquid from a constant temperature bath may be circulated through the jacket. In either case the temperature should be known accurately to at least 0.1°C.

The size of the various bulbs of the burette is not too important. A convenient range of volumes is 5, 15, 25, 50, 130 cc. If the volumes are too large the pressure increments will be large and the various readings may be too far apart for accuracy. On the other hand small burette volumes make it difficult to cover a reasonable range of pressures.

Adsorption Bulb

This is the container which holds the sample of adsorbent. There is no set design for such a bulb and the type used may vary according to the nature of the adsorbent. The principal requirements are low free space, i.e. no larger than necessary to hold the sample, and ease of construction. Several types are shown in Fig. 158. The simplest and the most convenient bulbs for most ordinary adsorbents are shown in Fig. 158, A and B. The adsorbent is introduced through the tube "a" which is then sealed off. The container, Fig. 158, C, is useful when the adsorbent is very finely divided. The two outlets decrease the rate of flow of gas and the glass fiber plugs stop the adsorbent from being blown out of the bulb during the degassing process. This is an important advantage for materials such as "fluid" cracking catalysts. The bulb, Fig. 158, D, is used when the adsorbent is of such a nature that it cannot be heated. The bulb is made in two parts, 1 and 2. The sample is placed in the bottom of 1. The bulb, 2, is then placed inside of 1 and the final seal made around the upper rim at 3. This seal is far enough away from the sample to avoid excess heating of the sample and yet the completed bulb has a minimum of free space.

The size of the adsorption bulb depends upon the adsorbent. It has been found that for most porous substances 0.2 to 0.5 gm. is a convenient sample size. For substances which are non-porous or which have small specific areas larger samples should be used. *To be continued*

REFERENCES

1. S. Brunauer, P. H. Emmett, Edward Teller, *Journal of the American Chemical Society*, Vol. 60, 1938, page 309.
2. L. G. Joyner, E. B. Weinberger, C. W. Montgomery, *Journal of American Chemical Society*, Vol. 67, 1945, page 2182.

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Vol. 2 MAY 1947 No. 5

Editorial

"BEHIND THE SCENES"

For all Sections except those few whose program activities are carried on the year round, this month—May—will see the last of the technical meetings of the season. Before the opening of the 1947-48 season, ordinarily scheduled for September, the Second National Instrument Conference and Exhibit will have been held in Chicago. For the Chicago Section, at least, the Conference will supplant the regular September meeting of 1947.

Between now and September, however, when most of us are anticipating or enjoying vacations, trips, golfing, fishing and other summer pleasures, many others of us will be busier than ever making preparations for, and taking care of, the myriad details connected with the "Instrumentation for Tomorrow" Conference and Exhibit. A good share of the work is being done by members of the Chicago Section.

Elsewhere in this issue will be found a list of the committees already set up and (in most cases) functioning in preparation for the September Conference. It will be noted that all the committee chairmen listed are Chicagoans. (A few of the committees, including the Educational Committee of which Dr. Teare of Pittsburgh is Chairman, are not indicated in the list mentioned.) When it is realized that each committee listed consists of from three to ten members, most of whom are Chicagoans and with but a few duplications, it will be apparent that a goodly number of Chicago people will have to drastically curtail their normal or planned summer activities this year in order to make possible the Conference and Exhibit for us to visit and enjoy.

The same was true of the Pittsburgh group last year, and the Philadelphia Section will find the same thing true next year.

By the same token, in many other Sections where local plans only are being considered, the summer vacation season is not too much of a vacation for many of the members. The officers, governors, committee chairmen and others will be expending as much or more time and effort then as during any other part of the season in arranging for speakers, programs, joint meetings, meeting places, etc. for the season to come. A good many members and visitors who attend and enjoy the monthly meetings thus arranged sometimes do not realize that a successful meeting doesn't "just happen." Instead of thinking only that "Mr. Doe was the finest speaker we've had this season—his talk was the best I've heard—etc," why not also give some credit to the officers and committee workers who worked hard to provide such an excellent program?

This is not intended to belittle the speaker who, in most cases, spends considerable time and money himself to bring to the meeting an interesting and educational paper, but this may be the only publicity or attention some of the "background" workers ever get. We, personally, cannot help but think that if more of the visitors at our meetings realize to a greater extent what goes on back of the scenes, more of them will join the I.S.A. *in appreciation of the benefits they obtain;* and if more of the rank and file members come to the same realization, more of them will step up and volunteer their services for committee work, etc., and relieve some of the burden on those few "old faithfuls" who carry the load now.

The old saying, "The more you put into the Society the more you will get out of it," is absolutely true (and we use it editorially ourselves quite often)—but it is true only up to a certain point! Some of us put so much into it (and then are asked to do more yet because we are "such willing and dependable workers") that the effort soon becomes a drudge and we are apt to lose interest entirely. If everyone pitches in and does his share, it will not take much of any one person's time, and we can *all* enjoy the Society and benefit from it and its activities as was intended when the organization was conceived.

For the work being done by the various committee workers in preparation for the Chicago Conference (or for any ensuing one, for that matter), the least we can do to show our appreciation is to attend the Conference and express our thanks to as many of the responsible individuals as may be encountered. The workers can not produce a successful Conference unless people come to it, and they will not be too eager to help in future Society affairs unless they know their efforts are appreciated. Let's *all* do our part.

—RRP

Editor's Notes

1. WHO'S WHO—TWO ISSUES BACK!

In the March issue of the *Journal*, the Who's Who column was occupied by President C. O. Fairchild, Delegate Harry Moore, Chairman (of Exhibit Committee) T. G. Robinson, and Chairman (of the Educational Committee) B. R. Teare, Jr. In all write-ups except that concerning Dr. Teare, the above information was included. However, three or four members who evidently follow this column pretty closely have recently asked us what Dr. Teare's position in the Society is (the questioners are probably newcomers, because everyone else knows who Dr. Teare is). Hence we now inform the readers that Dr. Teare is Chairman of the Educational Committee. We beg the readers' pardon for this oversight in the original write-up, and offer our profound apologies to Dr. Teare for having omitted a most important reference in the article.

Skipping now to the current issue, the Who's Who department this time is given over to Dr. R. H. Müller, Chairman of the Research Committee; and Philip Ewald, Chairman of the Emblem Committee. We unfortunately did not receive the material requested from the Delegate we intended to publicize this time, so will include his write-up in a future issue.

At the rate the ISA is gaining new Sections and setting up new committees and sub-committees, we are going to have to start "doubling up" on Delegates and committee chairmen in future issues in order to complete the series of Who's Who articles before some of them are out of office and new ones come along. Readers may therefore anticipate more and more of these articles in forthcoming issues as we re-adjust our schedule accordingly.

2. ONE PUBLICITY PROBLEM SOLVED.

The matter of favorable publicity is given very little thought by many Societies and by some Sections of our own Society, and yet publicity is one of the easiest of Society assets to obtain and one of the least expensive. The I.S.A. receives considerable publicity on a national basis through regular releases from the National Office, but the Sections can and should do their share in order to build up the prestige of the Society. One way to do this is to contribute regularly to the *Journal* which, as a part of *Instruments*, reaches far more readers than just the members of the Society. Another method is illustrated by the following letter from W. A. Reichow, *Journal* Correspondent of the Kansas City Section:

Editor, the *Journal*:

About two years ago the Technical Societies Council of the Kansas City Area was organized. Shortly after the organization, the Kansas City Industrial Instrumentation Society was admitted to membership. We are now affiliated with the Council under the name of "The Instrument Society of America, Kansas City Section."

The Council publishes a monthly official publication, *Pan Tech News*. I am attaching a copy of the March, 1947, issue. You will note on page 4 an article entitled "Instrumentation Comes of Age" by Robert B. Cooke, President of the Kansas City Section of I.S.A.

Since the Technical Societies Council is open only to nationally recognized technical organizations, I believe you would be interested in using this information illustrating the acceptance and progress of the Instrument Society of America.

Very truly yours, W. A. Reichow.

We are interested, indeed, and to the extent that we sought and obtained permission from H. K. Shidler, Editor

of *Pan Tech News*, to reprint the article by Bob Cooke in the *Journal*. It appears elsewhere in this issue under the heading given in Mr. Reichow's letter.

A number of Sections are affiliated with local Technical Societies Councils, most of which are more than glad to publish contributions by member societies. It might be worthwhile for these Sections to make a play for some of this free publicity, and in turn report it to the Editor of the *Journal* for a replay in these columns. If any Section is already enjoying this type of publicity, through Council publications or other media, let us hear about it. Perhaps the experience of one Section will help another into the right channels, and if there are any other publicity-getting ideas floating around, let's get them into the *Journal* where they can serve as examples or inspiration for other Sections to get on the bandwagon.

Many thanks, Mr. Reichow, for your contribution, and congratulations to Mr. Cooke and to the Kansas City Section for a fine bit of publicity gathering.

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Washington—for a concise and timely styling of advance notice information.

(Plus) a lot of little needles, *i.e.*, honorable mention, to Aruba, Baltimore, Central Indiana, Chicago, Southern Michigan and Tennessee for very good reports.

(It is with considerable pleasure that we note a great improvement recently in the Section News reports. We would like to see the trend continue. Maybe one of these days we'll have to turn the Needle around and pick out those reports which lean the wrong way! Do we hear any ideas on the subject?)

—R. R. PROCTOR

General News

INSTRUMENTATION COMES OF AGE

By Robert B. Cooke
President of Kansas City Section
The Instrument Society of America

(Reprinted by permission from PAN TECH NEWS, official publication of the Technical Societies Council of the Kansas City Area, March, 1947, issue.)

Grandma used to make soap in a kettle in the back yard and Uncle Ed flew his Jenny in World War I with a couple of instruments, and navigated it by the seat of his pants.

Today it takes a million dollar kettle and several dozen gages, meters and instruments to produce a bar of soap, but if the ads and operas are right it is pretty perfect soap; by the same token today's giants of the air require a bathroom-sized room of instruments and a flight engineer and two helpers to read them. But we can take off in New York after breakfast and have supper in Paris, and while yet several hours away the pilot knows when he will be there within a few minutes' time.

It didn't take any instruments, other than a clock or a calendar, to make soap Grandma's way, but the exacting standards imposed by competition require an exact knowledge by the manufacturer of his product at any and all points in the process today.

It was probably World War I that brought out the need for quality production in quantity and complete interchangeability of component parts and parallel characteristics of chemical solutions, so that they could be assembled with confidence at a point remote from their origin.

The internal combustion engine and the resultant race for superior fuels and lubricants all demanded complex control systems and equipment.

Instrumentation took its first large stride during that period.

Then came the synthetic age, when man improved on Mother Nature's production machine, and Nylon outmoded the silkworm; coal tars made better lasting dyes than vegetables and herbs; plastics made better gadgets than metal.

In large plants, the "fix-it man" could no longer maintain the dozens of different instruments used, and a group of technically trained men took over the responsibility. The correct application became even more complex, and process engineers made long and detailed studies before their control schemes were correct.

It was now apparent that there was needed unification and standardization of technics and equipment. World War II brought these to a head. A general pooling of "know-how" by industry and science was necessary if we were to achieve the quantity production demanded of America to arm herself and her Allies.

Locally, in April, 1944, individuals representing seventeen different firms in the Kansas City area met and organized the "Kansas City Industrial Instrumentation Society" with the object of the organization being "to promote the art and science of measurement and control of operating processes and their products, whether the units to be measured or controlled be gaseous, liquid, mechanical or electrical energy."

At about the same time in other manufacturing and industrial areas other groups were forming, but (in most cases) without the knowledge of each other's existence.

As the different locals became aware of the fact that there were other groups with similar interests and a common unity of purpose, the American penchant for organizing again displayed itself, and on January 10, 1946 the "Instrument Society of America" was finally organized as the tenth local section ratified the ISA Constitution on that date.

The Society is now comprised of 30 Sections and approximately 2000 members and associates. The rapidity with which the "ISA" has gained both sections and members is ample evidence of the need for such an organization.

The Kansas City Society has managed to maintain its membership with but a very slight drop even though the closing of several large "war plants" in this area brought about a material reduction in the number of instrumentation employees.

The high degree of member interest and participation in its activities is due to the sound principles on which the Section was founded through the untiring efforts of Wm. A. Reichow and Gordon Burke, the true fathers of this group.

The Section President Robert B. Cooke, Vice-President Oliver L. Boutros and Secretary-Treasurer R. Lee Lewis and the members extend a cordial welcome to anyone interested to come out to the Science Building at the University of Kansas City the fourth Tuesday evening of the month and visit the fastest growing technical society in the country.

CLEVELAND MEETING

The ISA members attending the Spring Meeting in Cleveland on April 24th will long remember the very fine program and entertainment provided by the Cleveland Section. The various committees deserve a vote of thanks, the following Cleveland members rate special mention: S. Bousky, H. R. Bowers, M. Estrin, A. A. Hejduk, C. Joy, M. Karns, Harvey Lee, Paul Lewis, A. J. McCullough, J. Prada, W. Sachse, G. [illegible] Sams, J. H. Waldrip and R. Woodside.

The speakers and the titles of their talks are listed below: Harvey Rockwell, Measurement of Light; Nelson Gildersleeve, Progress in Quality Measurement for Process Control; Gordon Volkenant, Modern Electronic Developments for Automatic Control; W. H. Fortney, Gadgets, Gimmicks, and Ways Out; John Victoreen, Instrumentation in Atomic Energy Research; Dr. Hugh L. Dryden, Measurement—Tool of Science and Industry.

Meetings Schedule

The following committees met on Wednesday, April 23, preceding the technical meeting: Education, Recommended Practices, Finance, Employment, Publication.

On Friday, April 25th, the Executive Committee met at 9 a. m., followed by the meeting of the Board of Directors at 11 o'clock. Reports of various committees were read, discussed and approved, some of which appear elsewhere in this issue. Further details of this meeting will appear in subsequent issues.

Recording Service

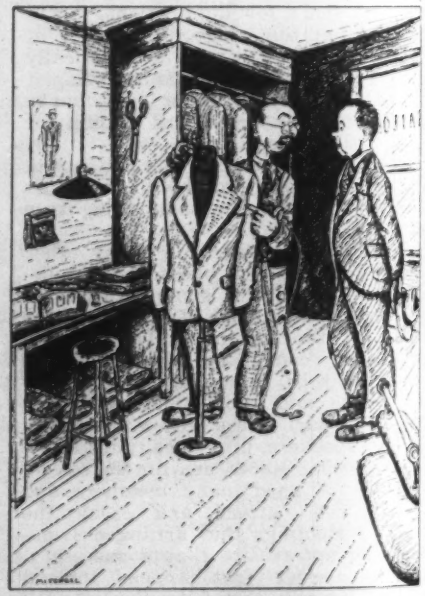
A vote of appreciation is hereby extended to the Brush Development Co. of Cleveland, and especially to Pete Odell, Manager of Instrument Sales and a member of the Cleveland Section, for providing two Soundmirror magnetic tape recorders, complete with operators (Brush employees), for recording all proceedings of the meeting. Our thanks to Pete and to his boys for a patriotic gesture and a fine job.

Coincidence

Following the evening program on Thursday, a party in the cocktail lounge found all five editors attending the meeting gathered at one table, with four of them acting as hosts to the fifth—the honored guest and speaker of the evening—Dr. Hugh L. Dryden of the National Bureau of Standards. The publications so represented were the *Journal of Aeronautical Sciences* (Dr. Dryden), *Instruments* (M. F. Behar), *Electronic Industries* (Ralph Batcher), *Industrial and Engineering Chemistry* (Dr. Ralph Munch), and the *Journal of the I.S.A.* (R. R. Proctor).

1947 Exhibit Space Nearly Sold

A report of the Meetings Committee included the very encouraging statement that less than 30 booths remain to be sold out



". . . a buttonhole for every need, I.S.A., A.S.M.E., A.S.Ch.E., Blood Donor, Red Cross, Community Chest, fraternity pins, etc. . . . and oh, yes, a pink carnation!"

f the 154 laid out for the Chicago Exhibit ext September.

embership Report

Dick Rimbach reported that the Society as grown from 1075 members in August 946 to 2200 members in April 1947!

Official News

Stickers and Cuts Available

To arouse interest in the forthcoming econd National Instrument Conference and xhibit at the Stevens Hotel, Chicago, September 8-12, stickers and cuts as illustrated herewith are now obtainable at no cost rom the National Office. It is suggested hat the stickers be used on letters and/or

nvelopes for your correspondence between ow and September 8, and on other literature, packages, etc. They are printed in red nd are gummed ready for use.

For those who would like to print the eal on their letterheads or in their publiations, it is suggested that a cut be rdered.

The stickers should be used freely where hey will do the most good, but should not e wasted. Place your order for as many tickers as you think you can use, or for uts, with the Secretary, Richard Rimbach, 1117 Wolfendale St., Pittsburgh 12, Pa.

To All Section Secretaries

Notices of further changes and additions o the previously published list of Section Delegates, Secretaries and *Journal* Correspondents have been received since the last hanges were published in the April issue. The following should therefore be incorporated in that list:

1. *Change of address.* Southern Michigan Section, I.S.A., Ken Mead—Secretary, 1919 Buena Vista, Kalamazoo, Michigan.

2. *Change of Correspondent.* South Texas ection, new *Journal* Correspondent is Mrs. eulah M. Smith. 1448 Southgate Drive, Corpus Christi, Texas.

3. *New Delegate.* Aruba Section, newly ppointed Delegate is William F. Hughes, P. O. Box 169, c/o Lago Oil & Transport Co. Ltd., Aruba, Netherlands West Indies. [Ed. Note—We have been advised that Aruba will be represented by their delegate or an alternate at the meeting of the Board of Directors to be held during the Second National Conference and Exhibit in Chicago this coming September!]

4. *New Sections.*

Cincinnati — *Secretary,* R. F. Romell, Vulcan Copper & Supply Co., 120 Sycamore St., Cincinnati, Ohio. *Delegate,* none elected yet.

Louisville—*Secretary,* S. W. Hawkinson, c/o Mpls.-Honeywell Regulator Co., Louisville, Ky. *Delegate,* E. H. C. Brown, 508 Creel Ave., Louisville, Ky.

South Bend—*Secretary,* George Gilliam, 202 Christman Bldg., South Bend, Ind. *Delegate,* none elected yet.

Twin Cities—*Secretary,* Ray Hopper, International Division, Minne.-Honeywell Reg. Co., 2753 4th Ave., Minneapolis 8, Minn. *Delegate,* None elected yet.

Binder Approved

At the meeting of the Board of Directors in Cleveland, a Reference File Binder was approved for distribution to all members, such a binder to be suitably inscribed with the Society emblem and designed to serve as a repository for permanent reference material, tables, data, and other information.

Some of the material to start this binder is to be issued by the Publications Committee with the binder, and it is the desire of the committee to try to satisfy the demand for the supplementary material most greatly desired by the members—and as soon as possible.

This is therefore a request for your ideas. What would you like to see made available as information to be released for inclusion in the binder? Please make your wishes known by sending your suggestions to the chairman of the Publications Committee, Dr. R. H. Munch, 303 Planthurst Rd., Webster Groves, Mo.

Obviously some of such material will require considerable checking and work before publication, and it may not be possible to get it into print soon, but the committee will consider all requests and do its best to oblige the majority demands first.

Summary of Employment Committee Report

Registered Applicants for Positions	
Graduates of Professional Courses..	78
Instrument Mechanics and Technicians	101
Student Registration	5
Consulting Engineers, Meter Services, etc.	13
Total Active Applicants.....	197
Registered Open Positions from October 1946 to April 1947	48
Positions filled by I.S.A.....	15

One of the important points brought out was the fact that there are too few applicants registered with the Committee. Many of the present applicants do not qualify for a specific position owing to education and experience not being directed to the field involved, lack of education and experience, age limits, desire for certain working areas, etc. An endeavor will be made to alleviate this condition by securing applicants from trade and vocational schools and universities. Sections were urged to publicize the employment activity of the Society to employers of instrument men in order to create a greater demand through the Society, and to offer a greater variety of open positions to the members. The Employment Register to be operated in Chicago during the Second Annual Conference will function as outlined in the April issue.

Society Emblem Approved

The final design of the official Emblem of the I.S.A. was approved at the meeting of the Board of Directors in Cleveland on April 25th, and is reproduced herewith about three times actual size.

The emblem is gold with black indications, and is designed to be worn either as a lapel button or as a watch chain key, the latter being slightly larger.

The history of the development of the Emblem is herewith presented in the form of a progress report by Phil Ewald, chairman of the Emblem Committee:

"The Emblem Committee, a sub-committee of the Membership Committee, has functioned informally and by correspondence since its inception. It has held no meetings as such. The task of selecting an emblem representing the objectives of the Society was started by C. O. Fairchild when he was chairman of the Membership Committee by appointing the writer chairman of the sub-committee. Other members of this group are Phil Putnam, Philadelphia, and S. E. Mitchell, Charleston.

"Casual inquiry among I.S.A. members produced a few ideas, but it was decided that the reaction of the membership at large would be desirable. Mr. Putnam, who designed the emblem used by the Philadelphia Section, was asked first to submit some designs. These, plus a few others garnered from other sources, were submitted to *Instruments* for publication. Editor Behar made up a number of drawings of additional ideas, expanded the request for publicity to a full page, and ran it in the August 1946 issue of *Instruments.*

"All received ideas were put on display at the Pittsburgh Conference and Exhibit and a straw vote taken of personal preferences. Since no one idea showed a marked lead over the next best, the novel ideas of the favorites were combined into one and the design submitted to the Board of Directors. Before official action was taken, further designs by S. E. Mitchell of Charleston were considered, and some of his ideas were used to improve the previously 'final' design. The design finally approved is based on the best ideas of all concerned, and should come closest to meeting the ideals of the interested membership, have the most effective advertising value, and be the most generally attractive to all concerned.

"We take this opportunity of publicly expressing our appreciation to the members of the committee for their diligent work, and to all others who were interested enough to submit ideas, suggestions and criticisms, and to those who voted or otherwise responded to our requests for comments on the various designs under consideration.

Philip Ewald, Chairman."

As soon as is practicable, the new emblem will be adapted for use wherever it is appropriate, such as for mastheads, publications, stationery, etc. Cuts will be made available in several sizes, and details on ordering these, as well as pins and keys and their cost, will be published as soon as possible.

Section News

ARUBA

Our 9th meeting was held on April 1, 1947, at the Engineers' Club. President A. S. MacNutt called the meeting to order at 7:15 p.m. Treasurer W. A. Koopman informed us that we were doing satisfactorily in his department, and M. A. Davidson, our representative to the Lago Community Council, presented a short report on the Council meeting of last month.

Details of the "mixed" picnic scheduled for April 15, at which the wives of the members would be guests, were explained by the Social and Recreation Committee Chairman, J. N. Faucett. After a "hot" election, W. F. Hughes was elected our delegate to the Board of Directors of the I.S.A. (The Republicans are strong in this area, too!)

Following the business meeting which lasted for almost an hour and a half, George Echelson gave us an informal talk on Radar, most of which was based on his experiences while attached to the Air Corps during the past war. Echelson's subject certainly held our attention since we spent some 18 months carrying out our job here under "black-out" conditions, and Radar was one of the most important defenses in this area.

To former Captain George Echelson we all heartily joined in with a "well done" at the conclusion of his talk. At this point we stopped to enjoy hot drop donuts and sandwiches, prepared by Mrs. E. H. Pfeffer and Mrs. G. Echelson, and hot coffee by Paul Jensen.

Through the courtesy of the Wright Aeronautical Corporation, we then viewed a sound motion picture, "Cyclone Combus-

tion," which proved to be of interest and was well received. The meeting was adjourned at 10:25. —JIM LOPEZ, *Sec'y.*

BALTIMORE

The Baltimore Section enjoyed several very pleasurable activities during the month of March beginning with the regular meeting which was held at the Engineers' Club on Friday evening, March 7.

At this meeting 73 members and guests assembled to enjoy the honor and privilege of hearing a speaker who has won world-wide recognition as an authority on Flow Measurement, L. K. Spink, Head of Flowmeter Engineering of the Foxboro Company, Foxboro, Mass. Spink, who is the author of several books on flow measurement as well as the inventor of several calculating instruments, connections, and control instruments, spoke on the subject "Flow Engineering." His talk, illustrated with slides, was very instructive as well as interesting. Attention was called to the present trend toward continuous rather than batch processes, which places more and more emphasis on the rate type of meter. Following a discussion period during which Spink graciously answered questions and explained some of the more difficult points, refreshments were served.

On Tuesday, March 11, the Council of Officers held a business meeting at the close of which a farewell party was given at Munders Lauraville House for Byron Dewey, formerly of Petroleum Chemicals, Inc., who is leaving Baltimore to take charge of instrumentation for the Airco Plants of the Air Reduction Company of Stanford, Conn. Dewey, who was chairman of the Membership Committee, always took an active interest in I.S.A. activities and the Section deeply regrets seeing him leave.

On Friday, March 21, 35 members and guests were conducted on a field trip through the plant of the Crown Cork and Seal Company, which all enjoyed greatly.

—KENNETH R. MILLER, *Corr.*

CENTRAL INDIANA

Members of the Central Indiana Section enjoyed a very interesting illustrated talk on "Measurement and Analysis of Sound and vibration" at their regular meeting on April 8. The speaker, William R. Saylor of the General Radio Company, explained to the group the operation and uses of sound level meters and sound analyzers, and the method of making use of a parallel T network in these instruments. Operation and uses of vibration meters and vibration analyzers were also explained.

Saylor had these various pieces of equipment with him and they were inspected by the members with great interest. Kipling Adams, of the Chicago office of General Radio Company, assisted Saylor in demonstrating and explaining the instruments.

L. Gess, of the Brown Instrument Company, will give a talk on Flow Meters at the May 1st meeting of this Section. At the June 3rd meeting Robert Miller, Supervisor of the Elgin Observatory, is scheduled to give a talk on "Measurement of Time." The program will include a showing of the motion picture "Time."

—M. W. HANSON, *Corr.*

CHARLESTON

Monday, May 5, 1947—"Combustion and Feedwater Control," by C. H. Barnard, Bailey Meter Company.

CHICAGO

The regular April 7 meeting of the Chicago Section featured an inspection trip through the Northwestern Technological Institute at Northwestern University, and claimed the record for attendance at any meeting this year. Over 140 members and friends enjoyed the dinner meeting at the Georgian Hotel in Evanston, and 160 made the trip through the Institute.

The dinner meeting at the hotel featured brief addresses by Dean Eshbach and Dr. Klopsteg of the Institute, both of whom discussed the activities and plans of the Institute with special emphasis on instrumentation activities.

At the Institute a number of laboratories were open for inspection, and the guests were free to visit those activities which were of greatest interest. Judging by the interest aroused, the electron microscope, chemical instruments, technical measurement, control systems and the microwave laboratories were highlights of the tour. In addition to these laboratories, others in the departments of Civil Engineering, Mechanical Engineering, Electrical Engineering and Physics were open. Members of the staff and graduate students were on hand to describe the equipment and, in a number of cases, demonstrations were carried out.

Arrangements for the inspection trip were made by R. W. Jones, Associate Professor of Electrical Engineering, Northwestern Technological Institute, who also acted as technical chairman at the dinner meeting. The event was enjoyed by all.

Two meetings are planned for May, one scheduled and the other unscheduled. The latter is a "Users' Pep Meeting" at which the views of the users of the Section are to be aired, with special emphasis on the types of programs preferred, policy, how to interest more users in joining, and how to promote greater user activity in committee work, program participation, etc. This meeting is to be held May 5. The regular May meeting is to be held May 12 at the Furniture Club of America, and will be a combination Annual Business Meeting and Social Night with entertainment. This meeting is for the ladies, as well as for the members and guests.

—JOHN C. VAALER, *Corr.*

DETROIT

The March meeting of the Detroit Section featured F. R. Brydges, Instrument Engineer for the Post Products Division of General Foods Corporation, and P. C. Skeels, head of the electronics division of General Motors Proving Grounds.

Brydges, in his talk on "Unusual Control Problems," outlined four basic systems and discussed several practical methods of instrumentation applicable to flow and liquid level measurement and control. He concluded his talk by listing these four types of control assignments given to instrument engineers:

1. Set up a control system but don't spend any money!
2. Improve the present system as cheaply as possible.
3. Re-establish control by any means but keep the process going.
4. Design and build best possible system regardless of cost and time.

Skeels' illustrated lecture on "Electronics Applied to Counting Problems" described and demonstrated an interesting electronic counter used for counting revolutions of test engines but adaptable to many other applications. This instrument can faithfully indicate rates as high as 200 counts per second, and may be actuated by impulses as small as the radio signals emitted by an automobile ignition system..

In a short business meeting prior to the evening's talks the proposed by-laws of the Section were presented to the membership by the Executive Council. After some discussion they were unanimously accepted as amended. Chairman of the By-Laws Committee Emil Gillig was commended for his fine job. Several members of other Sections attending the meeting requested copies of these new By-Laws; additional copies may be obtained by addressing Secretary, Victor G. Raviolo, Ford Motor Company, Village Rd. Bldg., Dearborn, Mich.

Chairman Milton Weber of the Membership Committee reported that the Section membership had reached 100. His committee's goal is 150 members by June.

Our April 28th meeting was addressed by O. G. Rutemiller, Consulting Engineer, who spoke on "The Motron Servomechanism." The April demonstration featured Wheelco Temperature Control Instruments and Combustion Safeguard Equipment, with C. L. Clark in charge. On May 26, Dr. M. H. Nichols, of the University of Michigan, is scheduled to talk on "Telemetering Problems in Flight Research." On June 23, the subject of "Automatic Controls for Production Machinery" is to be discussed by representatives from the following companies: Micromatic Hone Corporation, Monarch Machine Tool Company, and Moore Products Company. —SIEGMUND KULKA, *Corr.*

EASTERN NEW YORK

The Eastern New York Section held its April meeting on Tuesday evening, the 8th, at Siena College, Loudonville, New York.

We were honored twofold by having J. B. McMahon who, in his capacity as Vice-president of the I.S.A., extended the greetings of the national organization, and then assumed his role of speaker for the evening, presenting a very enlightening talk on "A Non-Mathematical Discussion of Flow Measurement." The lengthy question period which followed his talk was proof in itself of the enthusiastic reception of his talk. The meeting did not break up until 10:30 p.m.

At our May meeting we will hear about the goings-on "Behind the Instrument Dial" as described by Lawrence Parachini, Manager of Educational Activities and Public Utility Sales, Weston Electrical Instrument Company, Newark, N. J.

—W. J. CLAFFIE, JR., *Sec'y.*

KANSAS CITY

Our March meeting was held on the 25th at the University of Kansas City. The speaker of the evening was Dr. George Ziegler, Executive Scientist of the Midwest Research Institute of Kansas City. His subject was "Today's Research—Tomorrow's Industry."

Following his short paper which outlined the work being done at the Institute, the members and guests were taken on a personally conducted tour of the Institute. Here, Dr. Ziegler showed us at first hand the work being done with special emphasis on the part that instruments play in research.

The Midwest Research Institute is backed generally by Kansas Citians, and in particular by the industries in this territory. Consequently it is doing considerable research in furthering the use of the natural resources of this area, particularly foods. However, the Institute is also engaged in developing industrial items which are at the present time being manufactured outside the Kansas City area.

Our May 27th meeting will feature J. L. Cottrell of the Pittsburgh Meter Division of Rockwell Manufacturing Company, who will talk on "Orifice Meters and Their Installation."

It should have been noted previously that our elected President, Robert Cooke, had to resign because of a change in employment which took him away from Kansas City. V.P. Oliver Boutros has consequently assumed the Presidency of the Section for the remainder of the season.

—R. L. LEWIS, *Sec'y.*

LOUISVILLE

The Louisville Section April meeting was addressed by V. V. Twig, Foxboro Co. on "Derivative Control." It was agreed by all concerned that such a program as given by Twig was well worth holding the meeting at high noon if it would suit his convenience.

This meeting marked the passing of the fifty paid-up-members mark, and we are now shooting for a hundred.

—E. H. C. BROWN, *Pres.*

NEW JERSEY

The usual zest for argument was missing at the Forum Meeting held at the Essex House on April 1 by the New Jersey Section. Perhaps the fact that it was April Fool's Day made everyone a little hesitant; however, there were some good topics introduced for discussion and the meeting was attended by an unusually large group.

Harry Moore, who with Bill Ludi and Dick Roberts served on the Nominating

mmittee, announced the following slate the coming year:

For President: Sid Baran of R.C.A.
Vice-Pres.: Herb Close of National Lead Co.
Secretary: George R. Feeley of Trinity Equipment Corp.
Treasurer: Walt Maurer of Taylor Instrument Co.

Elections will be held at the May meet-, Tuesday, May 6. The speaker at this eeting will be Bruce Irwin of Hammel-ahl Company, who will talk on "Control ive Application." As this will be the last eeting of the year at the Essex House freshments will be served after the meet-g to celebrate the conclusion of a very ccessful year.

The June meeting will be an inspection ip through parts of the Calco Chemical ompany, and along with announcements the May meeting, return post cards will sent out for reservations for this meet-g. As the dinner will be served at Calco, will be necessary for all those wishing to ttend to make reservations in advance. If embers encounter any problems in con-ection with making reservations, get in uch with John Kelly of Calco Chemical o., Bound Brook, N. J.

—GEORGE R. FEELEY, *Corr.*

NEW YORK

The 48th meeting of the New York Sec-ion was held at the Men's Faculty Club at olumbia University on Monday, March 31. ixty-six members and guests were present r supper.

The business portion of the meeting con-sted of several announcements by Presi-ent Hildenbrand, the reading of the min-es of the previous meeting and the an-ouncement by the Program Chairman, alph Batcher, that the topic of the next eeting would be "Instrumentation in Rus-a."

Professor Kayan, as technical chairman, troduced the speaker for the evening, Dr. C. Mouzon of Brown Instrument Com-any, Philadelphia. The subject, "Indus-rial Applications with Electrical Resist-nce Methods," was well presented. In eneral, it was a survey of the field of easurement where resistance changes are ccomplished by changes in such para-eters as temperature, pressure, magnetic eld and light. Means of measurement of esistance and of amplification of the ef-ect were explained. Several demonstra-ions were presented to illustrate various onditions affecting resistance.

The meeting adjourned at 10 p.m.

—CHARLES D. COREY, *Corr.*

OAK RIDGE

The regular April meeting of the Oak Ridge Section, held on April 1, featured J. A. Michaelson of the General Electric Company of Schenectady, N. Y. The dinner portion of the meeting started at 7 p.m., followed by the business and technical meetings.

The subject of Michaelson's talk was "New Developments of the General Engineering and Consulting Laboratories." The discussion was well illustrated with a number of slides.

The business meeting was called to order at 8 p.m. by President A. V. Novak. The minutes of the last meeting were read by Secretary A. H. Fowler, and H. V. Fisher, as chairman of the Program Committee, reported on the activities of his committee. Chas. W. Covey presented a report on the activities of the Publicity Committee, of which he is chairman. A lively discussion of a forum series exclusive of the regular meetings was carried on with no definite conclusions being reached. It was announced that the discussion would be continued at the next meeting with more details available to bring the question to a desirable conclusion. N. L. Isenhour, National Delegate, spoke briefly concerning the recent activities of the National Office.

The speaker of the evening was introduced by the chairman of the Publicity Committee, C. W. Covey. The photometer and a photo-recorder were described. A high speed electron counter was discussed and its application as a projectile counter pointed out. An electronic wide-band frequency meter was also described. Actually a tachometer, the instrument can count up to 60,000 rpm. An electro-mechanical measuring gage was discussed, and the G. E. Torque-meter and the Vapor Detector were explained. A new Dew-Point Recorder was described from a schematic on the screen. The photographing of projectiles and shock waves with an electronic stroboscope was explained and several interesting photographs were shown on the screen.

An interesting informal discussion followed the technical portion of the meeting.

Dr. H. A. Straus of Monsanto Chemical Company, Oak Ridge, will speak on "Servomechanisms" at the May meeting.

V. D. Hauck, Chief Engineer of the Friez Instrument Division, Bendix Aviation Corporation, will speak at the June meeting on "Radio Sonde—Present Status of the Art."

A seminar is currently planned for the July meeting. —CHAS. W. COVEY, *Corr.*

PHILADELPHIA

(The following items were taken from the mailed announcement of the April meeting, as no formal report was submitted this time —ED.)

46th Meeting, Wednesday, April 16, 1947. "Liquid Level Measurement and Control by Variable Displacement," by Paul Wing, Jr., Mason-Neilan Regulator Co.

May meeting, Wednesday the 21st. "Industrial Electrochemical Measurement and Control" by Dr. Willard N. Greer, Ph.D., Leeds & Northrup Co.

PITTSBURGH

The March meeting of the Pittsburgh Section was held on Monday, March 24, at the Carnegie Library lecture hall. Eighty members attended. A technicolor picture produced by the Lindberg Engineering Company entitled, "Heat Treating of Metal Parts" was shown. This was followed by a brief business meeting. Charles Cochrane of the educational committee announced the distribution of questionnaires to be used in determining the demand for a training course for instrument mechanics to be inaugurated in the vocational departments of the Pittsburgh public school system next year. Jacobs of the nominating committee announced the names of nominees for next year's officers and introduced the nominees. Wayne Farley was appointed chairman of the new Trip Committee whose function will be to arrange tours through various plants in the Pittsburgh district. At the conclusion of the business meeting O. F. Benson of the American Meter Company, Inc., gave a talk on "Flow Measurement."

The next meeting of the Section will be held on Monday, April 28, 1947. The subject "Automatic Proportioning of Gases and Liquids," will be presented by B. J. Velten, Askania Regulator Company, 1603 So. Michigan Avenue, Chicago 16, Illinois.

For the May 26th meeting, John C. Whiddett, of Automatic Temperature Control Co., Inc., is scheduled to speak on "Time Controls in Industry."

—A. G. YOUNG, *Corr.*

ST. LOUIS

The St. Louis Section held its regular March meeting at the York Hotel in St. Louis on Monday, March 31, 1947. Attendance was approximately 75 members and guests.

D. P. Parker, Manager of the Technical Department of the East St. Louis refinery of the Socony-Vacuum Oil Company, was the speaker of the evening. He covered the importance of petroleum products during the late war, when the army literally "moved on its petroleum products." Sixty percent of the weight of all material shipped to the army in the field from this country consisted of products derived from petroleum!

Parker pointed out that petroleum was known in prehistoric times, and was used for medicinal purposes, tracing the development of petroleum refining up to the present time, listing the dates of the advent of the more important products. The fact that modern refinery operations are peculiarly adapted to automatic control and instrumentation was brought out by Parker with the aid of many excellent drawings and slides. All types of temperature, flow, liquid level, pressure and other indicating and control instruments are used, as well as some instruments not known to other industries. The talk, entitled "The Role of Instruments in Petroleum Refining," was very interesting and well presented.

W. C. Rosenbaum announced that the St. Louis Section's Employment Committee has several openings available, and requested employers and instrument men to take advantage of the committee's facilities.

The regular meeting scheduled for Monday, April 28, will feature Louis Gess, Brown Instrument Company, who will speak on "Flow Meters—Design and Application."

On Monday, May 26, special entertainment is to be provided as a feature of the "Season's End Party."

—H. E. ZEFFREN, *Corr.*

SOUTH BEND

The regular monthly meeting of the South Bend Section was held on April 17 at the Engineering Building, Room 5, University of Notre Dame. H. C. Frost, Assistant Director of Research, Chemical Division, Corn Products Refining Co. of Chicago, Ill., presented a paper entitled "Some Considerations in the Control of a Continuous Process." Frost covered a typical continuous flow process, stressing the importance of coordination between the development of the chemical process and the instrumentation needed to indicate, record, and control that process.

The next meeting will be held at 7:30 p.m. on May 22 in Room 5, Engineering Building, University of Notre Dame. Dr. Karl Schoenherr, Dean of Engineering of the University of Notre Dame will cover some aspects of the instrumentation problems encountered at the David Taylor Model Basin during the war.

—GEORGE GILLIAM, *Sec'y.*

SOUTHERN MICHIGAN

Sixty-three members and guests attended the April 16th meeting of the Southern Michigan Section at Chicken Charlie's in Kalamazoo. President Wade Allen opened the meeting by introducing the new members and out-of-town guests. Eight applications for new membership were received before the meeting.

Program Chairman Oliver Woods then introduced the speaker of the evening, Carl Lee, Chief Engineer of Radio Station WKZO, Kalamazoo, who discussed the timely subject of "Frequency Modulation." Lee covered the early development of FM transmission, explaining the difficult time Armstrong (the inventor of the FM principle) had in securing a station license.

Some of the merits listed for FM were static elimination and high fidelity. Lee explained that less power is required to keep the signal-to-noise ratio in line for good reception, but that the standards required of the FM broadcasting station far exceed the standards set up for receivers. He also showed that there is room for 4000 FM stations in the new 88 to 108 megacycle FM band, as compared to only 1200 AM (Amplitude modulation) stations in the 550 to 1500 kilocycle band.

Lee then demonstrated the Brush Magnetic Tape Recorder. We listened to a recording of a news broadcast, a band and an organ. He then made a recording of some of the members talking, and played it back immediately—producing a big laugh among those present. A lively discussion period followed.

At the May 14th meeting, Theodore A. Cohen, Presdent of the Taco-West Company, will discuss "The Electronic Phases of Automatic Control Apparatus" and special problems of pyrometry.

—KEN MEAD, *Corr.*

TENNESSEE

The 23rd meeting of the Tennessee Section, ISA, was held at the Civic Auditorium in Kingsport, March 12, 1947, with dinner at the Kingsport Inn before the meeting.

Business consisted of a discussion of the program for the balance of the year. The method of handling nominations of candidates for office was reviewed. The May meeting was announced as the annual business meeting and all members were urged to be present. The section was fortunate in having present J. B. McMahon, National Vice president who took an active part in the business discussion and answered many questions pertaining to national policies.

McMahon then presented his talk on "A Non-mathematical Discussion of Flow Measurement." Starting with the history of flow measurements, he continued through the various stages of tests and development to the most recent accepted standards. Proper installation methods were stressed. An interesting discussion of the subject followed his talk.

The April 9th meeting was also held at the Kingsport Inn in Kingsport, Tenn. Business consisted of a general discussion of grades of membership with corresponding benefits. Progress of the membership drive committee was reported by George Moorehouse, Chairman.

Henry W. Stoll of the Taylor Instrument Companies, Rochester, N. Y., was the principal speaker. Interest in his discussion of "Flow Measurement" was intense. Questions from the floor, followed by Mr. Stoll's timely solutions, directed the course of his talk.

The May meeting will be the annual business meeting. Election of officers will be held then. —F. H. THEILE, *Sec'y.*

WASHINGTON

The next three meetings of the Washington Section are scheduled as follows:

April 21. Chas. S. Packard, Chief Engineer of Struthers-Dunn, Inc. will address the Section on the subject "Electrical Operation of Small Mechanisms."

May 19. George W. Baughman, Chief Engineer, Union Switch & Signal Company, will talk on the subject "Railroad Instrumentation." His discussion will cover electronic equipment developed to increase reliability and safety of signaling devices on the railroads. As an added attraction, a 30-minute color movie depicting the interesting history of the railroading industry will be shown. This General Electric picture entitled "Railroadin'," was released by General Electric and the American Locomotive Company, and took over a year to produce. The program promises to be one of the big attractions of the year.

June 9. Anthony H. Lamb, Chief of the Relay and Thermometer Engineering Division, Weston Electrical Instrument Corporation, will be the speaker. His subject will cover the development and applications of the Photronic Cell and associated circuit components such as sensitive relays, many ingenious models being developed by Weston during the war. Lamb contributed much to the development of the Photronic Cell and the Sensitive Relay. His talk will be followed by a short movie which will reveal the intriguing marvels of the "phototube" and which demonstrates many commercial applications.

—E. L. DEETER, *Chmn. Meetings Com.*

WAYNE COUNTY

The Wayne County Section of I.S.A. met on April 21, at the Presbyterian Church House in Wyandotte, Mich. The dinner was held at 6:30 and the meeting at 8:00.

The meeting was opened with the drawing of the door prizes.

The following officers were elected for the coming year: George Huff, President; Charles Chessrown, 1st Vice President; Robert Wright, 2nd Vice President; George Rogers, Secretary; Fred Munchausen, Treasurer.

The speaker of the evening was H. W. Auraz of the Brown Instrument Co., who gave a very interesting talk on "Some Practical Aspects of Automatic Control."

Our next meeting will be on May 19th at which time T. A. Cohen will talk on "Electronic control." —W. S. BAKER.

Who's Who in the I. S. A.

PHILIP EWALD

Since the official emblem of the Instrument Society of America was approved at the meeting of the Board of Directors in Cleveland on April 25, it is appropriate to devote a portion of the "Who's Who" department in this issue to the man who is responsible for the development of the final design of the emblem, Philip Ewald, Chairman of the Emblem Subcommittee, of Sheffield, Alabama.

"Phil" was graduated in Engineering Physics in 1935 from the University of Michigan, and almost immediately afterward joined the TVA Department of Chemical Engineering at Muscle Shoals, Alabama. His work there has been principally instrumentation, including design and installation of instrument systems for large scale chemical processes, organization and supervision of research and plant instrument laboratories, and research and development work on instruments for special applications.

Indulging in his hobbies is a serious business with Phil. He has been an amateur radio fan since high school days, and is known on the air as W4EWR. Since his college days he has also been a gliding and soaring enthusiast. In addition, he indulges in hunting, fishing and boating on TVA lakes, miniature photography, clarinet and phonograph records, and writing for technical journals! As to where he finds time for all this, Phil explains by saying that he is still an active member of the local Bachelor Club.

He is a member of I.S.A., A.C.S., A.P.S. and A.A.A.S., and of the hobby organizations A.R.R.L., Soaring Society and C.G.A. He is a member of the I.S.A. Membership Committee, and was appointed in 1946 by President Fairchild (then chairman of the Membership Committee) to head the subcommittee to secure an emblem for the Society. That it has taken so long to complete the task is no fault of Phil's, as is shown in the report of the committee's activities elsewhere in this issue.

R. H. MÜLLER

Dr. Ralph Holcombe Müller, Chairman of the Research Committee, has been engaged in the teaching and direction of research in various branches of instrumentation for the past sixteen years. His early training was in chemistry; he obtained his B.S. degree from Pennsylvania in 1922, and his M.A. and Ph.D. from Columbia in 1923 and 1925 respectively. In 1927 he engaged in post-doctoral research in physics in Göttingen.

Dr. Müller has published research in radiation, photoelectric photometry, electronics, instrumental methods of analysis and the design of scientific and industrial instruments. He was associated with New York University from 1924 to 1942, where he still holds the rank of Professor of Chemistry. From 1942 to 1946 (June) he was engaged in research and field engineering in radar at the Radiation Laboratory of the Massachusetts Institute of Technology.

Since January of 1946 he has been Contributing Editor on "Instrumentation in Analysis" for the Analytical Edition of *Industrial and Engineering Chemistry.*

The Research Committee, of which Dr. Müller is chairman, functions to recommend and expedite the carrying out of research problems in various fields of instrumentation. The committee to date has been engaged in a careful "feeling-out" of its fields of usefulness, and a forthcoming progress report will be published as soon as it becomes available. Other members of this committee are M. F. Behar (Pittsburgh), C. F. Kayan (New York), T. R. Harrison (Philadelphia), and Ed S. Smith (New York).

ISA EMPLOYMENT SERVICE

In printing these announcements the Society assumes no obligation as to responsibility of employers. Those replying to announcements should include two copies of their reply. When testimonial documents are to be included, copies of such documents and *not* the originals should be sent. The Society regards acknowledgment by employers of all applications as an act of courtesy but can assume no responsibility for their failure to do so. Address all replies to Employment Committee, Instrument Society of America, 1117 Wolfendale St., Pittsburgh 12, Pa.

—C. F. GOLDCAMP, *Chmn. Employ. Com.*

SITUATIONS OPEN

INSTRUMENT MECHANIC by large process manufacturer to service Hays automatic control on three 800hp. Erie boilers, CO_2 recorders, flow meters; temperature recorders on dryers, cooking kettles and kilns. Must be able to make efficiency checks throughout plant. Salary $250.00 per month. Location Southern Illinois. Box 49.

• • •

INSTRUMENT MECHANICS for maintenance and repair of all types of oil refinery instruments including flow controllers, temperature and pressure regulators, etc. Give detailed outline of previous experience, as well as complete personal information. Hourly basis. Permanent. Location East Central United States. Box 50.

• • •

ENGINEER, young man with some knowledge of instruments and air operated diaphragm control valves as salesman to work out of New York District office of old established manufacturer. Box 51.

• • •

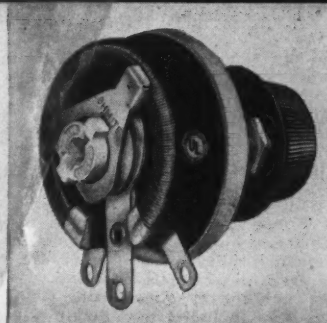
PHYSICIST or **ENGINEER**, A.B. or B.S. degree in radio or electrical engineering to assemble, calibrate, and repair instruments used to measure radiation. Also to conduct radiation surveys. Headquarters New York City but must be in a position to travel. Civil Service appointment. Salary $4,900.00 plus transportation and travel allowance. Box 52.

• • •

CHEMICAL ENGINEERING Ph.D. for Assistant Professorship in Chemical Engineering Department of midwestern University. Must have experience in instrumentation as opportunity will be afforded to develop this specialty within the department. Box 53.

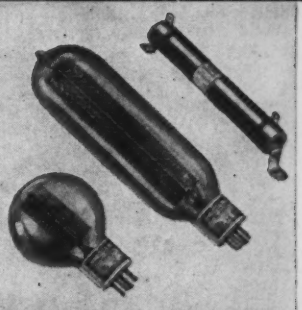
Be Right with.. **OHMITE**

Vitreous Enameled Rheostats



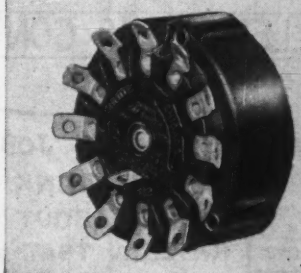
Available in 10 sizes, ranging from 25 to 1000 watts, in a wide range of resistances. Ceramic parts insulate the shaft and mounting. The resistance winding is permanently locked in vitreous enamel. The metal-graphite brush provides unmatched smoothness of action. Engineered and constructed for long, trouble-free life.

Non-Inductive Resistors



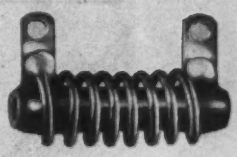
Used as dummy antennas for radio transmitters, load resistors in high frequency circuits, and terminating resistors for radio antennas. Available in vitreous-enamel type wound on a tubular ceramic core and in hermetically sealed-in-glass type mounted on a 4-prong steatite tube base. Sizes from 50 to 250 watts.

All Ceramic Tap Switches



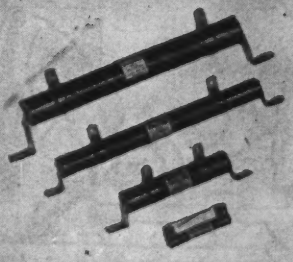
A popular switch for use with tapped transformers in power supply units. Compact, dependable, and convenient to operate. Available in ratings of 10,15,25,50, and 100 amperes, A.C. Contacts are of the silver-to-silver, non-shorting type. Switch shaft is insulated by a strong ceramic hub. The heavy, one-piece ceramic body is unaffected by arcing.

Parasitic Suppressor



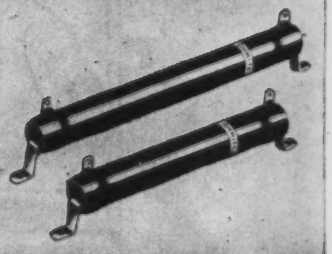
Designed for the suppression of unwanted ultra-high frequency parasitic oscillations due to incidental resonance between tube plate and grid circuits of push-pull and parallel operated transmitting amplifiers. Consists of a 50-ohm vitreous enameled non-inductive resistor which supports a choke of 0.3 microhenries and .003 ohms d-c resistance.

Radio Frequency Plate Chokes



For use in the plate circuits of diathermy oscillators and amateur, aviation, police, and commercial short wave transmitters. Consists of a single layer winding on a steatite core, rigidly held in place, insulated and protected by a moisture-proof coating. Rated at 1 ampere.

Wire Wound Resistors



Ohmite offers a complete line of dependable resistors wound on a ceramic tube and protected by vitreous enamel. Ratings from 10 to 200 watts. Available in the fixed type for general use, and in the "Dividohm" type with adjustable lugs for use as a multi-tap resistor or voltage divider.

OHMITE MANUFACTURING CO., 4886 Flournoy St., Chicago 44, U. S. A.

OHMITE

Write Today for Ohmite Catalog No. 18

Provides 16 pages of useful data on the selection and application of rheostats, resistors, tap switches, chokes, attenuators, and other equipment.

Technical Society News

AKRON INSTRUMENT SOCIETY

No report of our February meeting was sent in due to the illness of Ye Scribe, and our March meeting was blown away with the blizzard, but the Akron Instrument Society is very much alive and kicking.

The April meeting was held at the Akron YWCA on Tuesday, the 25th, with 45 members and guests present. Speaker for the evening was Mr. Paul Wing, of the Mason-Neilan Regulator Co. His subject, "Control Valves," is one which every instrument man knows all about (of course!) but he was surprisingly able to bring out a number of facts which were new to us—and which gave us a better perception of the important part played by the lowly valve tucked away somewhere on a pipe line.

Mr. Wing pointed out that on open-closed service, strength of spring is a simple matter but, on close throttling control, springs have to be carefully engineered, taking into account size of seat, size of top, pressure in line and pressure drop to be absorbed by the valve. The question of pressure drop is an important one, a 150-lb. drop being the maximum desirable for standard service. Pressure drops above this require special consideration for satisfactory performance.

Regarding single- and double-seated valves, Mr. Wing stated that type of service is the determining factor. Where tight shut-off is essential, single seats are best, as double-seated valves require special grinding technique to be tight-seating; whereas, for modulating control, double seats are best, owing to inherent force-balance characteristics.

The next meeting will be on Tuesday, May 27th, time and place to be announced later. The speaker will be Mr. L. V. Parsegian, of the C. J. Tagliabue Co., and his subject "Principles of Potentiometer Pyrometers." —FRED APPEL, JR., *Sec'y.*

BOSTON INSTRUMENT SOCIETY

The Boston Instrument Society met at 6:30 p. m., April 9th at Thompson's Spa in Boston.

Mr. J. B. McMahon of the Republic Flow Meters Co., Chicago, Ill., and Chairman of the Committee on New Sections of the Instrument Society of America, had as his subjects:

(1) Shall we join the I.S.A.?
(2) A non-technical address on Flow Measurement.

Mr. McMahon stated the many advantages to be gained by having our Society join the I.S.A. He described the different membership classifications and answered questions in regard to the present and future plans of the I.S.A. His address on Flow measurement was well received by our members.

Mr. H. S. Fairchild who presided, announced that at the May meeting which will be the last until September, there will be the election of officers and a vote will be taken on joining the I.S.A.

—J. H. CONDON, *Corr. Sec'y.*

SOUTHERN CALIFORNIA METER ASSOCIATION

The May meeting of the Association will be held at the usual place, Rio Hondo Country Club on Thursday evening, May 22. Dinner will be served at 6:30 and the meeting will start at 8:00.

Mr. Warren of the Mineralight Black Light Products Company will speak on "Ultraviolet Light in Prospecting and Industrial Applications." There will be a supplementary program of general interest.

An excellent turn-out was had for our April meeting at which Mr. Claude Nolte, Manager of Sales for the Barton Instrument Company, spoke on "The Sizing of Control Valves." —CHARLES MERIAM

AIR NAVIGATION FACILITIES

William A. M. Burden, Assistant Secretary of Commerce, in a speech at the Aviation Dinner Meeting of the Society of Automotive Engineers in New York, declared that "the greatest single factor in achieving a really major improvement in safety and regularity lies in the improvement of our system of air navigation facilities. The improvement of those facilities involves the solution of two problems: a financial problem and a technical problem. . . .

"The government is facing the necessity of large additional capital expenditures on the airways and increased expenditures on research if it is to do its job of developing civil aviation properly and is to reap the economic returns that will come from a rapidly-growing air transport industry. The radio facilities which comprise the airways system are largely obsolete. Most of them were designed fifteen years ago. The first stage of a program for the replacement of the low-frequency ranges with modern VHF types and the widespread installation of instrument landing systems and approach light lanes was included by the Congress in CAA's budget for fiscal 1941. Then came the war during which the armed forces quite properly obtained the entire output of the United States radio industry. And after VJ-day, although Congress included substantial sums for VHF and ILS installations in our fiscal 1946 budget, the deliveries of equipment by the radio manufacturing industry have as yet been only a trickle. . . . The war and its aftermath, reconversion, have thus produced a delay of nearly five years in the practical modernization of our airways system. . . .

"There is no doubt that the sums expended by our government on the airways system and in the support of civil aviation generally have proved a good investment just as our federal expenditures on highways and our land-grant aid to railroads have been a good investment in building up great industries which have made the country what it is today. . . .

"As I need not remind you engineers, one must avoid the temptation of calling a halt to orderly progress every time a promising new gadget glimmers over the horizon. . . .

"The CAA-industry program for improved instrument weather approach facilities has been carefully evolved and contains all the elements which are now actively highlighted in the public press—ILS, GCA, high-intensity approach lights and radar tower surveillance. . . .

"The equipment of large numbers of key airports with ILS, GCA, high-intensity light and even a very few with FIDO will require a very substantial investment, probably 20 to 40 millions. I believe it will be a sound investment. . . ."

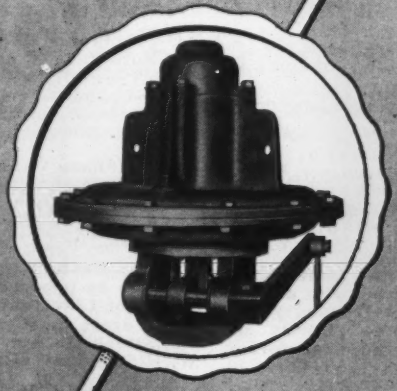
WHEN A FELLER NEEDS CONTROL BY Putt
NICE NEAT JOB JOE - BUT I DON'T THINK TH' BOSS CARES ABOUT THE FLOW RATE IN THAT HANDRAIL. I SAID THE STEAM LINE YOU LUG!
IDEA BY GENE CRUMLISH E.I. DuPONT de NEMOURS & CO.

Instruments pays $5.00 for each idea used. Sender's name and company affiliation will be acknowledged in the cartoon unless we are specifically requested not to do so. Address Cartoon Dep't, *Instruments*, 1125 Wolfendale St., Pittsburgh 12, Pa.

SERIES 600

DIAPHRAGM AIR MOTORS

Furnished as one unit — complete with North American Adjustable Port Valves.



Used with pneumatic type instruments for throttling control of air, gas, oil, water or steam.

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For Combustion

THE NORTH AMERICAN MFG. CO.

GAS OR OIL COMBUSTION EQUIPMENT • BRANCH OFFICES IN PRINCIPAL CITIES

CLEVELAND 5, OHIO

Adjustable Port Fuel Valve and Motor

Butterfly Air Valve and Motor

Adjustable Port Air Valve and Motor

FLOW RATE METER ELIMINATES "BUBBLE COUNTING"

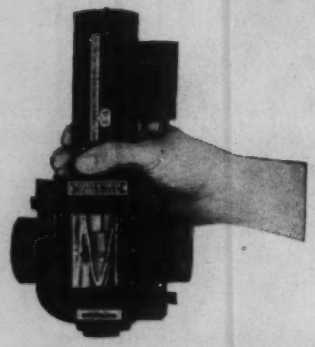
This compact flow meter is the answer to purge line (Bubbler) control installation.

. . . true purge rate indication
. . . easily and neatly panel mounted singly or in multiple, requires a minimum of space.
. . . furnished with or without needle control valve.

$9.00 per unit, without control valve (lower price when purchased in quantity).

Write for catalog 31

NEW FLOW SWITCH PROTECTS VALUABLE EQUIPMENT



The Ratosight-Alarm provides continual visual indication of flow rate and responds instantaneously to flow rate changes only. A magnetic extension on the "metering-float" trips external switches to operate the alarm circuit. The alarm flow point is adjustable over the entire flow range and operates accurately at the set position. Built in sizes up to 1½" and stocked in cast iron and brass.

PRICES NOW REDUCED BELOW WAR-TIME PRICES
Write for catalog 92.

FLOWRATOR
TRADEMARK
FISCHER & PORTER CO.
DEPT. 7P-5C HATBORO, PENNA.

Manufacturers' New Literature

In this department we report new literature pertaining to Instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on page 487.

O-205 **Bin Level Indicator.** 6-page 4" × 9" Folder 788 pictures and describes the "Bin-Eye," a diaphragm-operated mercury switch for indicating or controlling the level of materials in bins. Jeffrey Mfg. Co., Columbus 16, Ohio.

O-206 **Recording Galvanometers.** 7-page 8½" × 11" Bulletin 7-100 describes and gives technical information on maker's "Type 7-100, 7-200 Series" recording galvanometers. Consolidated Engineering Corp., 620 N. Lake Ave., Pasadena 4, Calif.

O-207 **Pipe Locator.** 2-page 8½" × 11" bulletin pictures and describes the "Globe Radio Type Pipe Finder" for locating piping underground, in walls, under flooring, etc. Globe Phone Mfg. Corp., Reading, Mass.

O-208 **Photoelectric Colorimeter.** 8-page 8½" × 11" Bulletin No. 500 pictures and describes the "Hellige-Diller" photoelectric colorimeter. Hellige, Inc., 3718 Northern Blvd., Long Island City 1, N. Y.

O-209 **Low-frequency "Q" Indicator.** 4-page 8½" × 11" bulletin pictures and describes "Type 1030" low-frequency "Q" indicator which measures directly the "Q" factor of coils. Freed Transformer Co., Inc., 72 Spring St., New York 12, N. Y.

O-210 **Transmitting Components.** 12-page 8½" × 11" Catalog No. 969 pictures and describes maker's line of radio and electronic components including capacitors, inductors, insulators, couplings, etc. E. F. Johnson Co., Waseca, Minn.

O-211 **Bin Level Indicator.** 4-page 8½" × 11" bulletin with inserts pictures and describes the "Bin-Dicator" bin level indicator for use with all bulk materials. Includes diagrams showing application to signaling or control systems. The Bin-Dicator Co., Detroit 15, Mich.

O-212 **Automatic Temperature Control Systems.** 20-page 8½" × 11" Educational Bulletin No. 5 consists of charts, tables and diagrams which explain measurement and automatic control and the selection of proper control systems for process applications. Wheelco Instruments Co., 847 W. Harrison St., Chicago 7, Ill.

O-213 **Tube Testers.** 4-page 8½" × 11" bulletin pictures and describes "Type 139" counter tube tester and "Type 140" portable tube tester. Sylvania Electric, Distributor Sales, Emporium, Pa.

O-214 **Pneumatic Control Valves.** 36-page 8½" × 11" Bulletin 277-1 pictures and describes "Stabiliflo" line of pneumatic control valves and controller accessories. Appendix contains information on computing valve sizes. The Foxboro Co., Foxboro, Mass.

O-215 **Vacuum-tube Voltmeter.** 2-page 8½" × 11" Bulletin GEA-4574 pictures and describes maker's a-c. vacuum-tube voltmeter. General Electric Co., Apparatus Dept., Schenectady, N. Y.

O-216 **Moisture Meter for Concrete Sand.** 2-page 8½" ×11" bulletin pictures and describes maker's moisture meter for indicating directly the percent of free moisture in concrete sand. J. Thomas Rhamstine, Harlingen, Tex.

O-217 **Electrical Measuring Apparatus.** 8-page 8½" × 11" Bulletin G-1 pictures and describes maker's line of electrical measuring instruments and components including resistance standards, d-c bridges, decade resistance boxes, bridge components, etc. Shallcross Mfg. Co., Collingdale, Pa.

O-218 **Power Rheostats.** 4-page 8½" × 11" Bulletin E-1 pictures and describes "IRC Type PRT (AN 3155)" power rheostats. Includes temperature-rise curves. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

O-219 **"Uses Unlimited."** 2-page 8½" × 11" Vol. 2 No. 4 of this house organ pictures and describes the new "V3-14" low-torque "Micro Switch." Micro Switch, Freeport, Ill.

O-220 **Draft Gage.** 4-page 8½" × 11" Bulletin 24-B pictures and describes the "Straight-Line Diafram Gage" for measuring draft in stationary or marine installations. Ellison Draft Gage Co., 21[illegible] W. Kinzie St., Chicago, Ill.

O-221 **Dead Weight Testing Instruments.** 6-page 4" × 9" folder pictures and describes maker's line of dead weight gage testers and accessories. The Refinery Supply Co., 621 E. 4th St., Tulsa 1, Okla.

O-222 **Temperature Control Instruments for Electroplating.** 16-page 8½" × 11" Bulletin 98166 describes the application of maker's temperature control instruments to electroplating. Includes diagrams of typical installations. Taylor Instrument Companies, Rochester 1, N. Y.

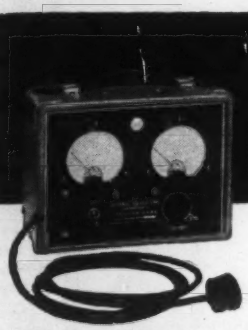
O-223 **Multi-layer Interference Films.** 2-page 8½" × 11" Bulletin MI-318 describes maker's multi-layer interference films for dichroic and achromatic beam splitters. Fish-Schurman Corp., 230 E. 45th St., New York 17, N. Y.

O-224 **Concentric-scale Instruments.** 12-page 8½" × 11" Bulletin GEA-3432B pictures and describes makers line of electrical indicating instruments with concentric scales. General Electric Co., Schenectady, N. Y.

O-225 **Constant-voltage Transformers.** 32-page 8½" × 11" Bulletin CV-102 pictures and describes maker's line of constant-voltage transformers. Includes charts and curves of performance characteristics. Sola Electric Co., 2525 Clybourn Ave., Chicago 14, Ill.

O-226 **Remote-positioning Control.** 4-page 8½" × 11" bulletin pictures and describes "Flectrol" electrical remote-positioning control system. Yardeny Engineering Co., 105 Chambers St., New York 7, N. Y.

O-227 **Vitreous-enameled Rheostats.** 4-page 4" × 8¼" bulletin pictures and describes maker's line of vitreous-enameled round rheostats in 7 sizes from 50 to 500



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Silicone News

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Gaskets of Silastic, however, need no conditioning. No plasticizers of any kind and no organic rubbers are added to Silastic. It is cured at temperatures beyond the limits of most organic rubbers and is non-volatile even at high temperatures and under high vacuum. That's why Minneapolis-Honeywell Regulator Co. uses gaskets of Silastic to seal high vacuum systems in which lenses are coated with magnesium fluoride vaporized at high temperatures.

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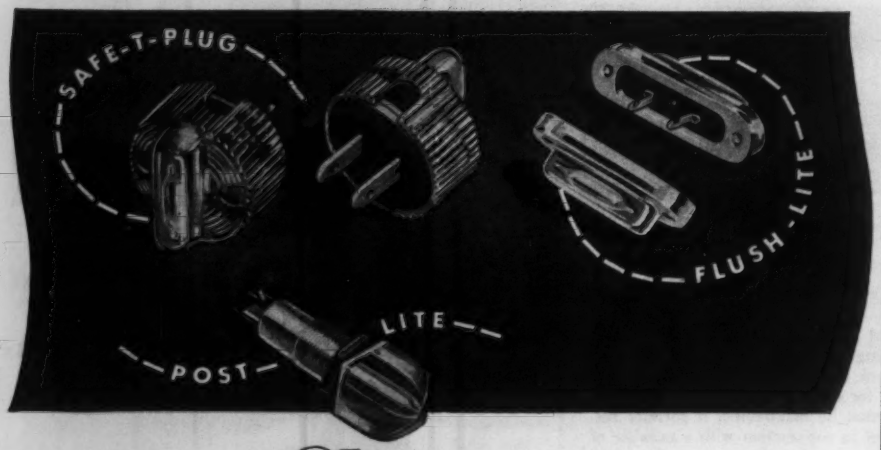

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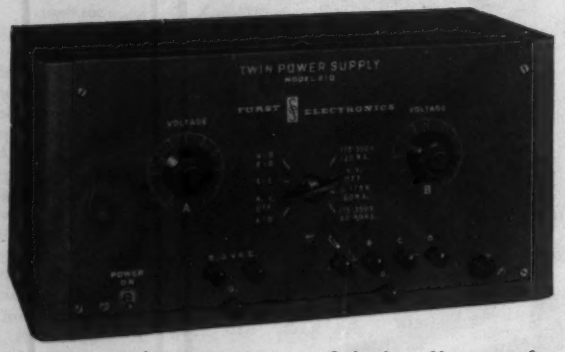

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watts. Rex Rheostat Co., Baldwin, L. I., N. Y.

O-228 **Decade Scaling Unit.** 2-page 8½"×11" Page 169 of Electronic Measuring Equipment Catalog pictures and describes "Type YYZ-1" decade scaling unit for nuclear research, radioactivity studies, mass spectrography, etc. General Electric Co., Electronics Dept., Syracuse, N. Y.

O-229 **"Wheelco Comments."** 4-page 8½"×11" Vol. 6 No. 2 of this house organ contains an article, "Electronic Temperature Control of Die-casting Equipment." Wheelco Instruments Co., Harrison & Peoria Sts., Chicago 7, Ill.

O-230 **Water Temperature Control Instruments.** 16-page 8½"×11" Condensed Catalog 3035 pictures and describes maker's line of instruments for water temperature control. Powers Regulator Co., 2720 Greenview Ave., Chicago 14, Ill.

O-231 **Pneumatic Valves and Cylinders.** 52-page 8½"×11" Bulletin 57-A pictures and describes maker's line of pneumatic and hydraulic cylinders, and manual and electrically-operated valves. Hannifin Mfg. Co., 621 S. Kolmar Ave., Chicago 24, Ill.

O-232 **Thermocouple Lead Wires.** 4-page 8½" × 11" Bulletin 30 pictures and describes, in table form, maker's line of thermocouple lead wires for pyrometers and thermocouples. Thermo Electric Co., Fair Lawn, N. J.

O-233 **Co-axial Connectors.** 4-page 8½" × 11" bulletin pictures and describes maker's line of co-axial connectors and co-axial-type low-pass filters. Diamond Instrument Co., 7 North Ave., Wakefield, Mass.

O-234 **Midget Resistors.** 8-page 8½" × 11" bulletin pictures and describes "Microtorque Potentiometers" for proportional control. Autoflight Instruments, 285 W. Colorado St., Pasadena 1, Calif.

O-235 **"Electronics in Automatic Chemical Feed Systems."** 16-page 6" × 9" Technical Paper No. 54 is a reprint of an article of the above title by Robert T. Sheen in *Transactions American Institute of Chemical Engineers.* Milton Roy Co., 133 E. Mermaid Ave., Philadelphia 18, Pa.

O-236 **Industrial Gages and Thermometers.** 20-page 4" × 9" bulletin pictures and describes maker's line of industrial gages, including pressure, vacuum, compound, altitude, hydraulic, ammonia, and diaphragm; also shows dial thermometers. James P. Marsh Corp., 2073 Southport Ave., Chicago 14, Ill.

O-237 **Vacuum Pump.** 6-page 4" × 9" folder pictures and describes maker's pump which can be used for vacuum or air blast. Eberbach & Son Co., Ann Arbor, Mich.

O-238 **Aircraft Receiver.** 6-page 8½" × 11" bulletin pictures and describes maker's "RA-10 Series" communication receiver for aircraft. Bendix Radio Div. of Bendix Aviation Corp., Baltimore 4, Md.

O-239 **Power Supply.** 2-page 8½" × 11" Bulletin Form 210 pictures and describes "Model 210" twin power supply for laboratories, etc. Furst Electronics, 800 W. North Ave., Chicago 22, Ill.

O-240 **Electrical Gaging Instruments.** 8-page 8½" × 11" Catalog G-1 pictures and describes maker's electrical strain-gaging equipment. Statham Laboratories, 8222 Beverly Blvd., Los Angeles 36, Calif.

O-241 **Stop Watches.** 4-page 8½" × 11" bulletin pictures and describes "Lemania" line of stop watches and chronographs. Bernard S. Lippman Co., 630 5th Ave., New York 20, N. Y.

O-242 **Vibrometer.** 4-page 8½" × 11" Bulletin No. 33 pictures and describes "Model 11-B" vibrometer for measuring vibration electronically. Televiso Prod-

...s Co., 7466 W. Irving Park Rd., Chi-...go 34, Ill.

...0-243 **60-cycle Filter.** Single sheet 8½" ...11" pictures and describes "Model 1050" ...-cycle filter for use in calibration of ...truments and measurement of harmo... distortion of amplifiers, transformers ...d tubes. Freed Transformer Co., 72 ...ring St., New York 12, N. Y.

...0-244 **Voltage Regulators.** 16-page 8½" ...11" Catalog S2-47 pictures and de...ribes maker's line of voltage regulators ...d "Nobatron" power supplies. Sorensen ...Co., Inc., 375 Fairfield Ave., Stamford, ...nn.

...0-245 **Pyrometers.** 16-page 8½" × 11" ...lletin 4361 pictures and describes mak...'s line of pyrometers in several types ...d sizes. Illinois Testing Laboratories, ...c., 420 N. LaSalle St., Chicago 10, Ill.

...0-246 **Stiffness Gage.** 6-page 8½" × 11" ...lletin 4506 pictures and describes the ...-5" stiffness gage for determining both ...e initial and normal stiffness of sheet ...d wire specimens. Taber Instrument ...rp., North Tonawanda, N. Y.

...0-247 **"General Radio Experimenter."** ...page 6" × 9" Vol. 21 No. 9 of this house ...gan is devoted to a description of "Type ...75-A" frequency monitor. Includes cir...it diagram and input sensitivity curves. ...eneral Radio Co., 275 Massachusetts ...ve., Cambridge 39, Mass.

...0-248 **"Ohmite News."** 2-page 8½" × ...1" February 1947 issue of this house or...an includes an article, "Wattage and ...urrent Relation in Resistors," which ...discusses the selection of resistors for ...pecific applications. Ohmite Mfg. Co., ...35 Flournoy St., Chicago 44, Ill.

...0-249 **Cycle Counter.** 4-page 8½" × 11" ...ulletin No. 139 pictures and describes ...Model AC-1" portable cycle counter for ...sting high-speed relays, welding timers

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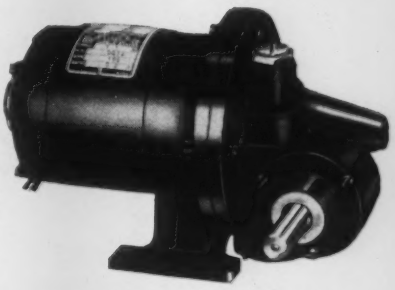

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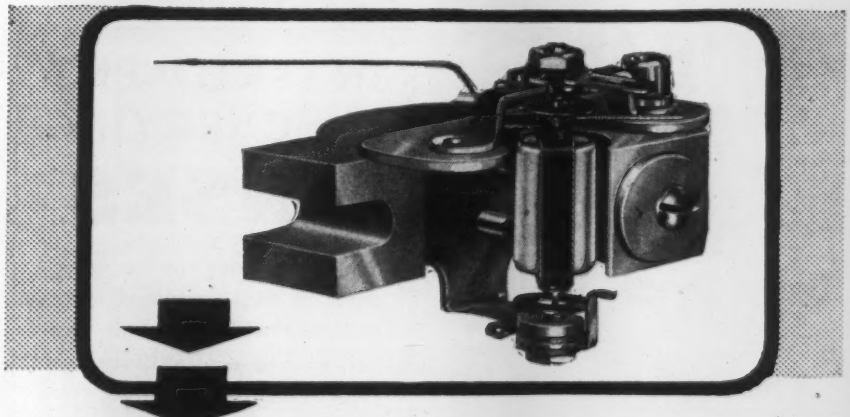

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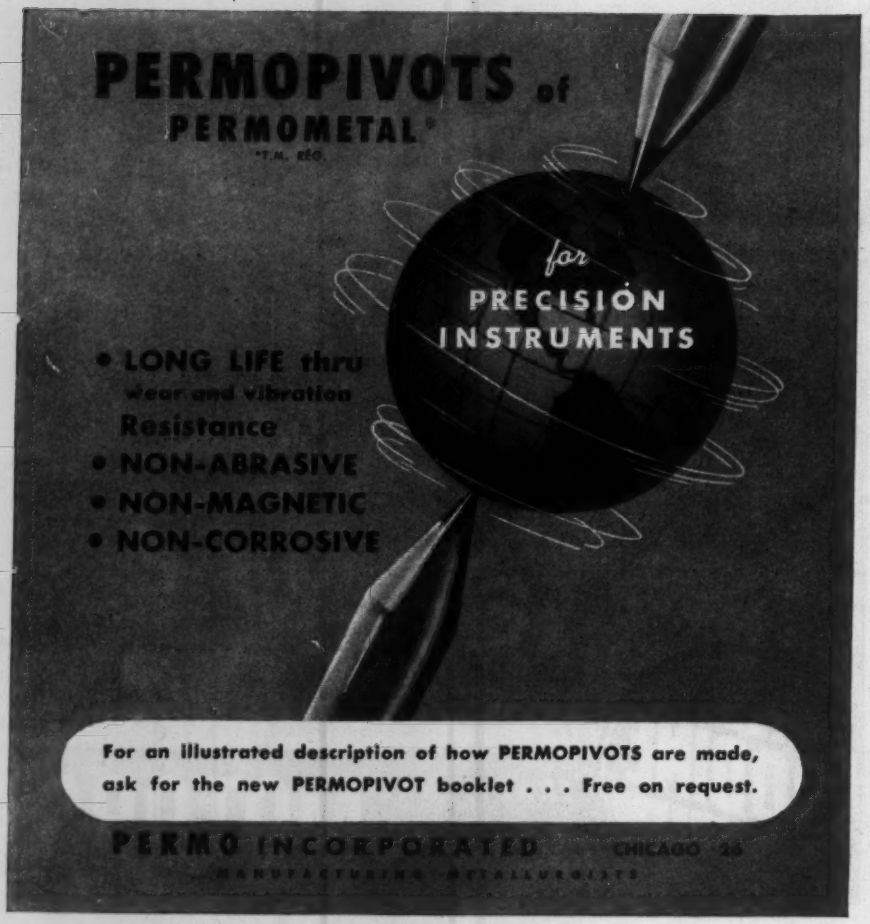

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O-250 **"The Gotham Bulletin."** 4-page 8½" × 11" Vol. 1 No. 2 of this house organ contains condensed descriptions of a number of the maker's controllers. Gotham Instrument Co., Inc., 149 Wooster St., New York 12, N. Y.

O-251 **Optical Benches.** 24-page 8½" × 11" Bulletin 156-74 pictures and describes maker's line of optical benches in single-rod, double-rod and lathe-bed types. Also lists optical bench parts and accessories. Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.

O-252 **Vacuum Thermocouples.** 6-page 4" × 9" Bulletin V22 pictures and describes maker's vacuum thermocouples for measuring small high-frequency currents and voltages. Field Electrical Instrument Co., 109 E. 184th St., New York 53, N. Y.

O-253 **Induction Soldering Unit.** 4-page 8½" × 11" bulletin pictures and describes maker's portable bench-type induction soldering unit. Marion Electrical Instrument Co., Manchester, N. H.

O-254 **Synchronous Motor.** 2-page 8½" × 11" bulletin pictures and describes "Model 805" fractional-horsepower motor said to maintain constant synchronous speed regardless of load and voltage changes. Fairchild Camera and Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y.

O-255 **Coating Thickness Gage.** 8-page 8½" × 11" Bulletin 2125 pictures and describes the "Aminco-Brenner Magne-Gage" for measuring non-destructively the local thickness of coatings on metals. American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.

O-256 **"Faxfilm Fax."** 2-page 8½" × 11" Vol. 1 No. 3 of this house organ contains a number of short articles on the use of the "Faxfilm" replica method of surface measurement. The Faxfilm Co., 1220 W. 6th St., Cleveland 13, Ohio.

O-257 **Resistors.** 4-page 8½" × 11" bulletin pictures and describes 19 types of inductive and non-inductive resistors. Includes sample. Precision Resistor Co., 330 Badger Ave., Newark 8, N. J.

O-258 **Feed Water Control Data.** 16-page 8½" × 11" Bulletin 105-B contains performance data on maker's three-element air-operated feed water control system. Includes diagrammatic layout of system and reproductions of charts from systems in use. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

O-259 **"Uses Unlimited."** 2-page 8½" × 11" Vol. 3 No. 1 of this house organ contains an article on the V-2 rocket entitled, "Practical Value of High Altitude Explorations." Micro Switch, Freeport, Ill.

O-260 **Perspective Drawing Instrument.** 8-page 8½" × 11" Folder Form PS-47 pictures and describes maker's "Stereograph" perspective drawing instrument. Pomeroy Stereograph Co., Inc., Ferguson Bldg., Cleveland 14, Ohio.

O-261 **"Modern Precision."** 8-page 10½" × 15½" Vol. 6 No. 3 of this house organ contains a number of short articles on applications of maker's instruments to industrial control problems. Leeds & Northrup Co., 4908 Stenton Ave., Philadelphia 44, Pa.

O-262 **Pressure Controllers.** 20-page 8½" × 11" Bulletin 462 pictures and describes maker's line of external-pilot-operated pressure controllers. Leslie Co., 225 Delafield Ave., Lyndhurst, N. J.

O-263 **"Weston Engineering Notes."** 8-page 8½" × 11" Vol. 2 No. 1 of this house organ contains an article entitled "Modern Thermometry" by A. H. Lamb, which discusses the development and use of the bimetal thermometer. Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

O-264 **Height Gage.** 4-page 8½" × 11"

Circular No. 486 pictures and describes the "Electrolimit" height gage for use in inspection rooms, tool rooms and in the shop. Pratt & Whitney Div., West Hartford 1, Conn.

O-265 **Illuminated Magnifiers.** Single sheet 8½" × 11" pictures and describes the "C-Master" illuminated magnifier with 4½" double convex lens. Ullman Products Corp., 857 4th Ave., Brooklyn 32, N. Y.

O-266 **Timing Motor.** 4-page 8½" × 11" Bulletin No. 10 pictures and describes "Type SX" self-starting synchronous timing motors with speeds from 1 rev./sec. to 1 rev./24hr. R. W. Cramer Co., Inc., Centerbrook, Conn.

O-267 **High Vacuum Equipment.** 8-page 8½" × 11" Addition to H-v. Equip. Catalog pictures and describes "Type VMF-150" fractionating pump and a Knudsen vacuum gage. Distillation Products, Inc., 755 Ridge Rd. W., Rochester 13, N. Y.

O-268 **Specific Gravity Indicator.** 2-page 8½" × 11" Catalog Section 91-B pictures and describes maker's compact continuous specific gravity testers for continuous indication of fluid specific gravity in closed piping systems. Fischer & Porter Co., Dept. 9D-B, Hatboro, Pa.

O-269 **Boiler Water Level Control.** 8-page 8½" × 11" Bulletin No. 465 is a case history of boiler water level control at West Reading Station of Metropolitan Edison Co. using maker's equipment. Northern Equipment Co., Erie, Pa.

O-270 **Pneumatic Transmission System.** 4-page 8½" × 11" Catalog No. 5902 pictures and describes the "New-Matic" remote transmission systems for applications where electrical transmission for indicating, recording and control of temperature, pressure, flow and liquid level is neither desirable nor permissible. Contains several schematic diagrams of typical applications. Brown Instrument Co., Wayne & Roberts Aves., Philadelphia 44, Pa.

O-271 **Polymeter.** 4-page 8½" × 11" Bulletin pictures and describes the "Type 34" polymeter, said to combine the advantages of the vacuum-tube voltmeter with wide-range measurement of resistance and current. Sylvania Electric, Distributor Sales, Emporium, Pa.

O-272 **Liquid Level Controllers.** 28-page 8½" × 11" Catalog 147 pictures and describes maker's all-electric floatless liquid level controllers. Describes principles of operation and gives application diagrams. B/W Controller Corp., 2200 E. Maple Rd., Birmingham, Mich.

O-273 **"The Laboratory."** 32-page 6" × 9" Vol. 16 No. 5 of this house organ contains an article entitled "Recent Advances in Fluorine Chemistry," descriptions of new laboratory instruments, and a table of laboratory conversion factors. Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.

O-274 **Conductivity Apparatus for Boiler Water and Condensate.** 4-page 8½" × 11" Bulletin RD-104 pictures and describes the "Solu-Bridge" conductivity apparatus for determining carry-over in steam, purity of distilled water, leakage of contaminating liquids into condensate, and boiler water concentration. Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.

O-275 **Electronic Equipment.** 100-page 6" × 9" 1947 Catalog pictures and describes electronic equipment and components for industrial and communications use. Walker-Jimieson, Inc., 311 S. Western Ave., Chicago 12, Ill.

O-276 **Boiler Water Level Controllers.** 4-page 8½" × 11" Bulletin 147 pictures and describes maker's boiler water level controllers, including standard multi-stage controllers, combination water column and controller, and single-stage control. Magnetrol, Inc., 2110 S. Marshall Blvd., Chicago 23, Ill.

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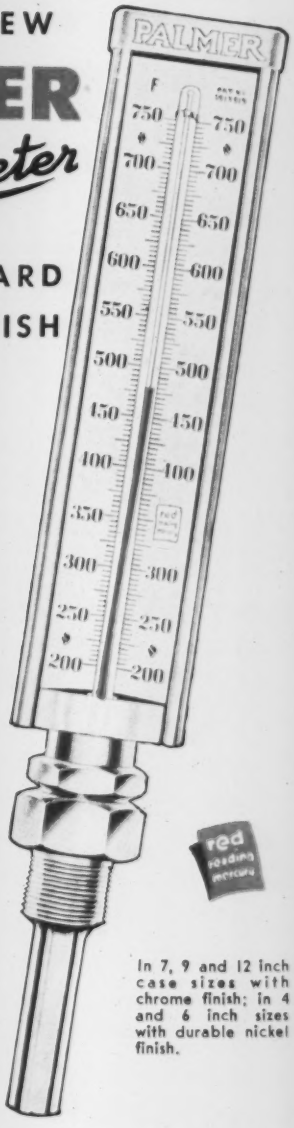

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